THURSDAY, JUNE 27, 1895.

"THE WIZARD OF MENLO PARK."

The Life and Inventions of Thomas Alva Edison. By W. K. L. Dickson and Antonia Dickson. (London: Chatto and Windus, 1894.)

THE present rapid increase in the number of places where the Edison Kinetoscope is exhibited, leads one to glance through the account which was published towards the end of last year of the life and adventures of the American inventor. The career of one who started as a newsboy, and who has raised himself to fame and wealth by his quickness of perception, fertility of resource, and general shrewdness, has been too varied and exciting for the authors to succeed in rendering the narrative uninteresting.

But the pages of rhapsody with which this long quarto book is filled, combined with the extremely verbose and grandiloquent style in which it has been written, not only render the meaning well-nigh unintelligible in many places, but give a wholly false notion of Mr. Edison's character. For those who have met him must have been struck with his somewhat boyish character, his fondness for a joke, and his objection to black coats, tall hats, and formality. The Edison of this book would hardly be recognised as the Edison who, we remember, some years ago could not be induced to put on his coat or shoes to receive an English peer, well known to science, who happened to call at Menlo Park when the inventor was taking his afternoon nap.

We start, of course, with Edison's pedigree, and we are told that his father, "Samuel Edison, however, was not minded to stimulate the waning flames of patriotism by a libation of personal gore." We should have thought the father of an inventor would have known that gore was not a good sort of kindling. Then comes a description of "callow collegians dragged through an uncongenial course of study, boarding-school graduates steeped in a weak solution of accomplishments, ephemeral creatures on whose glossy plumage the dews of Parnassus have no power to rest"; but Edison, on the contrary, "despite his paucity of years," read through "fifteen feet of closely serried volumes." Then we come to an excellent portrait of Edison at fourteen years of age, which strikingly resembles the closely shaven Edison of to-day, and shows the same merry twinkle of the eye.

Facsimiles are given of pages of Edison's newspaper, the *Grand Trunk Herald*, started in 1862, the vast number of blots on which are explained, we suppose, by the fact that this newspaper was regularly composed and printed in a dilapidated freight car attached to a running train. His next venture in the newspaper line, *Paul Pry*, led to his being ducked by a subscriber, and, as his travelling railway printing establishment and laboratory were burnt, through the constant jolting of the springless car shaking the cork out of a bottle of phosphorus, he turned his attention to the construction of a telegraph line. This was not attended with success, since to produce an electric current, "Edison secured two Brobdingnagian cats, with volcanic tempers, attached a wire to their legs, administered a violent amount of friction to their backs, and breathlessly awaited developments."

Afterwards he became a real telegraph operator, and when on night duty in the service of the Grand Trunk Railway of Canada, he was, in common with the other night operators, required to signal the word *six* every half-hour to show that he was awake. Preferring, however, to wander about the town, he obtained a clock and converted it into an automatic telegraph key. This key, however, would do nothing more than periodically signal the word *six*, and declined to answer inquiries, so a detective operator was put on the track, and Edison had to make his escape into the United States.

During the severe winter which followed, the ice broke the telegraph cable under the river which separates Port Huron from the Canadian city of Sarnia, on the opposite bank a mile and a half away, and further rendered all traffic across the river impossible. Communication between the two cities was, however, restored by Edison using the alarm whistle of a locomotive engine to send Morse signals. This power of overcoming difficulties brought him into public notice, and he obtained in succession several good posts as a telegraph operator. His love of fun and of making experiments, however, led him into constant trouble; but he was rewarded at the age of seventeen by making his first invention of an instrument for automatically repeating a telegraphic message.

Edison's electric device for killing cockroaches "is told in the prosaic terms of the nineteenth century," and commences, "Curiosity betrayed our Mother Eve," and so on for many lines. Edison's first patent for a "Vote Recorder" was not commercially successful, as its employment in the Massachusetts Legislature was found to interfere with the power of the House to use "*filibustering*." Then come his Universal Stock Printer and his employment as operator by the Law's Gold Reporting Company.

During the excitement connected with the operations of the Gould and Fisk ring to make a corner in gold, the stock quotation printer broke down, and Edison gave the very simple explanation that a contact spring had broken and fallen between two cog-wheels in the instrument. To describe this, however, the authors require several pages. "Inflamed by the lust of gold" (not Edison, however, for he was very poor at the time and owed 200 dollars), "and reduced to the semblance of insatiate brutes, the great sea of sentient humanity surged around the shrine of its desires," &c.

Chapter iv. commences with a description of "Edison's storm-tossed craft," and tells how "a steady gale blew from the Blessed Isles, wafting the adventurer into all tempting harbours of successful discovery." We much doubt the value of a wind blowing *from* an island, whether blest or not, to take a craft into its harbour.

In 1870 he was developing his automatic telegraph for transmitting a message by the use of a perforated strip of paper, and receiving it in Roman characters at the other end of the telegraph line; also instruments for automatically sending messages, using the Morse code, as in the well-known Wheatstone's Fast Speed instruments.

Next came the carbon button and the loud-speaking telephone. No reference is here made to Prof. Hughes microphone, or to the controversy which was carried on

about 1876, as to who invented the carbon telephone transmitter, and we are told that the Edison carbon transmitter "held the monopoly of the telephone in England for many years." In the next chapter, "the pretensions of his rival" are touched on, and Edison's remark, that "one of the biggest steals ever made was filched directly from my telephone," is quoted.

"The individual mistress of Edison's heart until now had been science, but a new potency was at hand equally strong, but immeasurably more subtle and all-pervading." Then the authors drop into poetry, which they have a way of doing on all possible occasions. Later on we are told that "prior to his marriage Edison portioned out the hours of sleeping and waking by the ebb and flow of the Divine afflatus," and that his "blood after having served the purpose of stimulating the capillary vessels of the brain, and inducing inventive capacity, soon retreats quietly to its legitimate source." We note in this chapter references to "Mrs. Noah's superior faculties," the Roman Empire, Carthage and her glory, a Phœnician axiom, and a disquisition on "the sickly and mercurial sentimentality of the Oriental and Latinic races," "the Plutonian broths of Sparta," "the delicious pastoral flavour to the *Allegretto* and the *Lycidas*." We presume Milton's title "l'Allegro" was not long enough for the authors; and all this while Edison has been left gazing at a test-tube in a large photograph on page 95 of this book.

By 1876 forty-five of his distinct inventions were in different processes of completion; £100,000 had been realised from the manufacture and the sale of patents; and the throng of sight-seers to Edison's laboratory at Newark became so great that he moved to Menlo Park, twenty-four miles from New York, and stacked there his "cases of every ordinary and extraordinary device born of that prolific parent, necessity."

The first sketch of the phonograph, on p. 123, is of real interest, for we regard the phonograph as scientifically the greatest of Edison's achievements, in that Edison accomplished with its use, in an extremely simple way, what the previous elaborate talking-machines could not perform. But why the microscopic examination of the tin-foil showed that "the feminine members of the alphabet were less aggressive in their outlines than their masculine coadjutors," or why the "long E vindicated her rights to female enfranchisement," we know not.

Descriptions of various forms of phonographs, phonographic dolls, &c., take us to the end of chapter xi. Chapter xii. is devoted to telegraphing from trains in motion, a subject that is certainly worthy of more consideration than it has yet received, and to Edison's pyro-magnetic motor, which, from its principle of construction, could never have been commercially successful.

The chapters on the development of the glow-lamp by Edison, and those associated with him, are some of the most interesting in this book. Phlegmatic indeed must be the reader who does not feel inspired by the enthusiasm which led Edison to despatch Mr. Moore to search through China and Japan, Mr. McGowan to explore the American continent from the Atlantic to the Pacific, and Mr. Ricalton to seek in India, Ceylon, and the neighbouring countries for a vegetable fibre suitable for being carbonised into a glow-lamp filament. But, if the reader be of a critical temperament, his pleasure at reading the account of these explorations will be diminished by the many faults which mar the description.

For example, the large picture on p. 217 of "Cingalese Women, photographed by Mr. Ricalton in his Search for Fibre," was never taken in Ceylon, since it is obviously a photograph of a group of *Japanese* girls posed in front of a theatrical back scene. One of these girls is sitting on a Western rustic garden-chair; so, perhaps, the photograph was taken in New York or Paris, on the principle followed by the special correspondent in the Soudan war, whose envelopes bore the St. John's Wood post-mark. Oddly enough, the book contains several other photographs of Cingalese people taken by Mr. Ricalton; but the authors do not seem to have been struck with the fact that a comparatively small island like Ceylon should have possessed inhabitants of such a variety of different types.

A great deal of tall talk follows about Edison's work on the dynamo machine. "Ah! potent wizard, you shame the records of the Arabian nights and the fabled glories of the East," &c., with the following surprising bit of information for the Englishman: "To-day there is not a hamlet in England, however insignificant, which is not in vital connection with the central sources of supply," that is, has electric energy supplied to it from a central electric light station. Passing over pages of grandiloquence; we come to a long description of Edison's factory and laboratories at Orange. The pictures remind us of what we ourselves saw when visiting Edison, but we have no recollection that in the laboratory "fragrant gums and spices recall memories of the fair Babe of Bethlehem." In fact, what we chiefly remember was our surprise at the large number of phonographs which we saw in course of manufacture, and Edison's sallies of laughter at the simplicity of the English in being so easily gulled by limited liability companies.

Although this book is in parts as silly as anything we have ever read, it is nevertheless full of interest; for it gives a graphic picture of the struggles and success of one who is certainly remarkable for his quickness of insight, originality, and capacity for long stretches of hard work, even if we do not agree with the authors that he is "the greatest genius of this or any other age." Even if we were not told on the title-page that the book was written by W. K. L. and Antonia Dickson, we should feel quite sure that it was a joint production, one of the authors being Edison's superintendent of the experimental department in New York, and the other a poetic rhapsodist who has never read her "Mark Twain." The illustrations are well executed, the printing and paper good, and the general get-up of the book all that can be desired of an expensive quarto volume to lie on the drawing-room table. But why was it not edited? asks the English reader. "P. D."

CRIMINAL IDENTIFICATION.

Finger-print Directories. By Francis Galton, F.R.S, (London: Macmillan and Co., 1895.)

IT will be remembered that the Departmental Committee which reported in the beginning of last year upon the best method of identifying habitual criminals, re-

commended the adoption of the Bertillon system of measurement conjointly with the plan of taking finger-prints now associated in this country with the name of Mr. Francis Galton. He loyally disclaims the honour of being the first to use it; that rests with Sir William Herschel, of the Indian Civil Service. But it is really from the unwearied labours of Mr. Galton that the scientific certainty of the system has been fully proved. He has so simplified the processes of taking and recording the impressions of the finger, has invented so complete and intelligible a series of indications and formulas, that the system can now be worked with the greatest facility and with mathematical precision. Of the supreme value of the finger-print as a means of identification, there can be no manner of doubt. It is, as Mr. Galton happily describes it, "an automatic sign-manual subject to no fault of observation or clerical error, and trustworthy throughout life." The Committee above quoted fully recognised this. "Finger-prints," they reported, "are an absolute impression taken direct from the body itself; if a print be taken at all, it must be necessarily correct." But they were met with the difficulty of classification as applied to any large collection of impressions. Where these were comparatively few, the index adopted by Mr. Galton was admirable and most effective. But where the numbers rose to many thousands, as would of course be the case in a criminal register, it might be a serious question whether searches could be made with reasonable facility and dispatch. It was for this reason that the double system of identification was recommended, for the strongest point in the Bertillon plan of measurement as practised in Paris was its perfect classification. There the particular card required, giving the name and antecedents of an individual, "could be found as certainly and almost as quickly as an accurately spelt word could be found in the dictionary."

Since then Mr. Francis Galton has devoted much time and very highly skilled intelligence to enlarging his methods of indexing and proving beyond all question the usefulness of the finger-prints. He now tells us, in his new work on "Finger-print Directories," how these indexes may be most easily and surely constructed, how the work of reference and search can be easily and quickly performed. Of course the result is largely dependent upon the size of the directory, the number of "sets" of impressions that have been collected to compose it. Mr. Galton's experiments were made with two collections, one of 300 complete sets of finger-prints, the other with 2632. In both, even with the largest, he was entirely successful. "The efficiency of a directory," as he says, "depends on its power of breaking up, with the maximum of surety and the minimum of labour, a collection of sets into groups of which even the largest shall be easily manageable, so that when a group is designated as that in which the set searched for must be, if it exists anywhere in the collection, it shall be quickly discovered." The collection that Mr. Galton finds most easily manageable is not necessarily the smallest, but that which lends itself best to search, in its character and its form. The one he has adopted is the card catalogue: "a collection of separate cards stacked behind one another in the separate order of their formula." Mr. Galton timed himself in his examination of 156 sets in his largest collection, which fell all under the same formula. Eight searches were made, during which a total of 373 cards were examined, and the time taken was a little over thirty-six minutes. Mr. Galton could therefore get through ten cards per minute, the trouble of opening the drawer or other receptacle having been done by an assistant. It is interesting to note that Mr. Galton in his inquiries first accepted the "whorl" as the basis of classification, thinking that from its almost endless variety of shape it would be the most useful of the three forms of impression; but as he went on he discarded it in favour of the "loop," the plainer forms of which could be "classed numerically by the simple expedient of recording the number of ridges in each of them that are crossed by an imaginary line drawn between two definite termini."

For a minute and detailed account of the primary and secondary classification of finger-prints, as well as for the best methods of taking them and studying their forms, we must refer the reader to Mr. Galton's new book. This most useful work contains a number of woodcuts and ample indications for the instruction and guidance of the student, with a specimen-book directory for three hundred sets. But whether the index is in the form of a book or of cards, Mr. Galton affirms, on perfectly good grounds, that it is quite possible to have "a finger-print directory, even of three thousand sets or more, that shall discriminate to within two or three sets." There can be no question, therefore, but that the whole system has passed out of the academic stage into one of real practical usefulness; and we may expect to see it applied for other purposes than that of criminal identification. Now that it has been made really manageable, it may be strongly recommended, for instance, to the military authorities as an infallible method of checking desertion and fraudulent re-enlistment. It appears that out of 35,000 men who enlist annually, 5000 desert, and only half are recaptured. Of the other half many, undoubtedly, re-enlist. Although the exact number cannot be positively fixed, it is estimated at 600, all of whom defraud the exchequer to the value of their second bounty and outfit. If, however, the finger-prints of all recruits were taken on attestation, and a register formed on the plan of the directories constructed by Mr. Galton, indisputable evidence would be afforded which would certainly convict the re-enlisted deserter of his original offence

BIRDS, BEASTS AND FISHES OF THE NORFOLK BROADLAND.

Birds, Beasts and Fishes of the Norfolk Broadland. By P. H. Emerson. 8vo, pp. 396, illustrated. (London: David Nutt, 1895.)

AFTER reading the severe criticisms passed on the works of several eminent British ornithologists—especially as regards illustrations—in the introductory chapter to the volume before us, we hoped we were going to be rewarded by finding something that would eclipse all previous efforts, both in the way of letter-press and plates. But we do not hesitate to say that in both respects we are disappointed. After all the writing about the "caricatures" of Bewick, and the "monstrous and gaudy decorations" of Selby, Gould, and Dresser, we find

only a series of very ordinary photographs, many of which have evidently been done from mounted specimens, and, what is more, from badly mounted ones. As to the text, we fail to see the reason for interlarding it with a provokingly numerous series of provincialisms, which, although no doubt familiar enough to the dwellers in East Norfolk, are certainly not household words in other parts of Her Majesty's dominions. To Norfolk people the names of "Herring-Spink," "Reed-Pheasant," "Spinex," and "Draw-Water," doubtless have a meaning, but we should be somewhat surprised if all our readers are aware that they respectively indicate the gold-crest, bearded tit, chaffinch, and goldfinch. It is true that in most cases the author does introduce a better-known name in the course of his notices, but this is not so with the "reed-pheasant." In omitting all scientific names, we are by no means sure that Mr. Emerson is not right, seeing that these are constantly being changed, while *English* names are permanent; but then let us have *English* names, and not *Norfolk* ones.

In the introductory chapter the author says indirectly that not much has been left out in regard to the habits of British birds; and we cannot help adding that if any important omissions do occur, he has done but little in the way of supplying them. Writing of the wren, he observes that "the tomtit, as the Broadsmen call this pert, child-like little bird, always brings an affectionate smile to your face as you see his hopping, plump little body flitting over the bank, or running along the branches of a leafless tree, stopping every now and then to sing his loud-voiced song; for, though his is a little body, he has a mighty and pleasant song." This example cited is only one of many taken almost at random. The professed ornithologist surely does not want such descriptions, and if the book is intended for the eyes of ladies and young people, why are we treated on p. 211 *et seq.* to a very unnecessary anecdote concerning the amours of swans?

We will take it for granted that among the birds our author has correctly determined the species he notices, and has recorded all those found in the Broads; but in the case of the mammals he is far from exact. He states, for instance, that there are two kinds of bats found there, one of which is designated the common, and the other the large bat. By the former is doubtless meant the pipistrelle, but as to the species indicated by the latter title we have no clue; and surely there ought to be more than two species of bats in Norfolk. Among the voles, again, we have two species, respectively termed the "red mouse" and the "marsh-mouse"; and, although the former may be the bank-vole, we can scarcely recognise the common field-vole under the latter inappropriate title, if so be that it is intended for that species. The Broadland rats (which the author places a long distance after the mice and voles) are likewise left in a state of hopeless confusion, and we quite fail to recognise what are the three kinds alluded to under the names of "big rat with yellow chest," "large brown rat," and "little red rat." If the author thinks he has got hold of new species, or the more fashionable sub-species, why did he not submit his specimens to a specialist? But as it is, his notes are useless to the scientific zoologist, and, we should think, of no great interest to the ordinary observer of nature.

In the chapter on frogs and toads, the author excels himself. Of these animals he recognises the following: viz. the "garden-toad," "water-toad," "running toad," "common frog," and "land-frog." To know what creatures are meant might perhaps tax the acumen even of Mr. Boulenger; but the notes on their habits are too naïve. The garden-toad, we are informed, "makes a form in the grass during the hot weather in which to shelter himself; and should you come upon him, he will squat with his bright eyes fixed upon you all the time." This merely records a fact known to every one; but what shall we say of the following concerning the running toad? "The chief thing in connection with this creature is the rockstaff that a man can quiet the most restive horse with the bone of a running toad, which, it is said, will swim against the stream. Yacht designers and others might well look into the matter." Apart from the grammar, what a rockstaff is, we do not know, and we are equally ignorant whether it is the toad or its bone that can swim against stream. A lack of information as regards species and habits is also displayed when the author comes to eels; and he seems to be totally unaware that some years ago the late Surgeon Day communicated an important paper on the breeding of these fishes to the *Proceedings* of the Cotteswold Naturalists' Field Club.

As to the literary style of the book, perhaps the less said the better; and although it may attain a popularity among the numerous frequenters of the Norfolk Broads, it is to be feared that it cannot take a high rank among zoological works. R. LYDEKKER.

OUR BOOK SHELF.

Object-Lessons in Botany. (Book ii., for Standards iii., iv. and v.) Being a Teacher's Aid to a Systematic Course of One Hundred Lessons for Boys and Girls. By Edward Snelgrove, B.A. (London: Jarrold and Sons.)

IT is not perhaps very often that elementary scientific books of the type to which the volume before us belongs, either meets with, or indeed deserves, much success. It is with the greater pleasure, then, that we feel that the author is to be congratulated on having succeeded in producing a really good series of lessons which will be most useful, either in guiding teachers in arranging their class work, or in enabling a student to acquire a knowledge of plants for himself. The series of lessons is progressively arranged, beginning with the simpler forms of leaves and stems, and passing on to the various types of flowers and fruits. The really excellent feature of the work is the method by which the student is led to examine actual plants. The book would probably be of little service to any one merely desirous of "getting up" the subject without troubling to form any practical acquaintance with the objects dealt with. The examples selected as types are well chosen, and the student (or teacher) receives plenty of hints as to other forms which he may usefully compare with them. Almost the only fault we have to find with the book is, after all, only a literary one; still, it seems a pity that the generic names of the plants should have been commenced with a *small* letter, especially in the chapters on botanical names. This, however, is a defect that can easily be remedied in a future edition, which soon should be needed, for we can cordially recommend the volume, both to the elementary teacher and student, as a thoroughly good one.

Dental Microscopy. By A. Hopewell Smith, L.R.C.P., L.D.S., &c. Pp. 119. (London: The Dental Manufacturing Company, Limited.)

STUDENTS of dental microscopy will find this work a valuable guide to the preparation, observation, and photography of microscopical sections of hard and soft dental tissues. The volume is practical throughout, and is illustrated by eight lithographed plates, from which typical structures may be readily recognised. It should prove of great assistance to workers in dental histology.

Organic Chemistry, Theoretical and Practical. By Prof. J. S. Scarf, F.I.C., F.C.S. Pp. 240. (London and Glasgow: W. Collins, Sons, and Co., Limited.)

WE find no feature which distinguishes this text-book from others "adapted to the requirements of the Science and Art Department, and of the London University." The book may assist students to pass the examinations for which it has been constructed, but it is not a desirable introduction to the science of organic chemistry.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Antiquity of the Medical Profession.

DR. BLACK displays a surprising facility of misapprehension—greater than I should have supposed possible.

The final sentence of his letter runs thus:—"It would seem, then, from history, that the medical profession is quite as old as either that of theology or law."

Now since the first sentence of my essay contains the clause—"In rude tribes it is difficult to distinguish between the priest and the medicine-man"; and since various illustrations are then given of the union of the priestly and medical functions in the same individual; and since it is thereafter shown that this union long continues among early civilised peoples—Egyptians, Babylonians, Hebrews, Hindus, Greeks—it is a necessary implication that, as Dr. Black says, "the medical profession is quite as old as either that of theology or law." For if two professions are at first exercised by the same persons they are necessarily of equal antiquity. So that, strangely enough, Dr. Black points out to me a truth which it is one of the purposes of my essay to teach. I can only suppose either that he did not read the first part of the essay at all, or that before he had reached the end he had forgotten the beginning.

Westerham, Kent. HERBERT SPENCER.

Halley's Equal Variation Chart.

I HAVE read Mr. Ward's interesting letter on this topic in NATURE of May 30, p. 106. I embrace this opportunity to correct some typographical errors in my letter in the issue of May 23.

No. 974 (4) should be 977 (4).

In foot-note 3, p. 79, the title of atlas referred to should be 'Tabulæ Nautic*al* Variationes Magneticas Denot*antes*."

I have compared Mr. Ward's description of his own chart with my notes. He evidently is the lucky possessor of the exceedingly rare Halley chart 977 (4). I should be pleased to have him inform me if the word "Britanniæ" in the dedication is not spelt with two *t's*.

The size of the British Museum copy is about 48 × 57 cm., the shorter dimension being in an east-west direction; it is in a splendid condition.

The earliest mention made of Halley's Equal Variation Chart is found in "Histoire de l'Acad. de Paris," 1701, p. 9. The chart referred to there must be the above 977 (4), of which we now know that two copies exist—the British Museum's and Mr. Ward's. L. A. BAUER.

The University of Chicago.

The Invention of the Net.

IN your number of February 28 (p. 417), Mr. R. I. Pocock suggests that the observation of a spider's web may have given rise to the art of netting. It is of interest to note that the following citation is found in a Chinese cyclopædia: "Yuen-kien Luihan" (1701, tom. ccccxlix. *art.* "Chi-chu," 2):—"In 'Pau-puh-tsze' it is said, 'Tai-hau [or Pâo-hsî] made a spider his master and knitted nets.'"

In the "Yih-King," the oldest authority that ascribes to Pâo-hsî the invention of the net, no mention is made in this connection of spider (see Legge's translation, in the "Sacred Books of the East," vol. xvi. p. 383); but the above-quoted passage of "Pau-puh-tsze" is tantamount to prove such a view, as suggested by Mr. Pocock, to have already occurred among the Chinese in the fourth century, A.D., when the book was written by a Taôist recluse named Koh Hung.

June 17. KUMAGUSU MINAKATA.

The Bird of Paradise.

I DESIRE to call the attention of your readers to a fashion which in the month of May was at its height in London, and is now much patronised throughout the country. I refer to the wearing in hats and bonnets of a graceful spray of soft fine plumes with drooping or curly tips. These the milliners call Bird of Paradise feathers, the assurance being constantly given that they are *real*. They are often mixed with osprey tips, which, to the shame of womanhood, have so long been in fashion, and are still largely used. I may state on trustworthy authority that during the past season one warehouse alone has disposed of no less than *sixty thousand dozens* of these mixed sprays!

The Bird of Paradise most used in millinery is that, obtained in the Papuan Islands and New Guinea. Mr. Wallace, in describing the *Paradisea apoda*, says:—"From each side of the body, beneath the wings, springs a dense tuft of long and delicate plumes, sometimes two feet in length, of the most intense golden-orange colour and very glossy, but changing towards the tips into a pale brown. This tuft of plumes can be elevated and spread out at pleasure, so as almost to conceal the body of the bird." In his "Oiseaux dans la Mode" of October 20, 1894, M. Jules Forest bitterly deplores the destruction which has been going on during the last decade. He emphasises the fact that it is no longer possible to procure such perfect specimens as were common ten years ago, since the unfortunate birds are so hunted that none of them are allowed to live long enough to reach full maturity, the full plumage of the male bird requiring several years for its development! He further states that "the birds which now flood the Paris market are for the most part young ones, still clothed in their first plumage, which lacks the brilliancy displayed in the older bird, and are consequently of small commercial value." Since January 1, 1892, strict regulations for the preservation of the Bird of Paradise have been in force in German New Guinea, and M. Forest appeals to the English and Dutch Governments to follow their good example.

The common sense of every thoughtful woman must at once tell her that no comparatively rare tropical species, such as the Bird of Paradise, can long withstand this drain upon it, and that this ruthless destruction, merely to pander to the caprice of a passing fashion, will soon place one of the most beautiful denizens of our earth in the same category as the Great Auk and the Dodo.

The women of England are earnestly entreated not to countenance the sacrifice of this bird by encouraging the demand for its precious feathers. Let them resolve to do what they can to prevent the extermination of this "wonder of nature" by stoutly refusing to purchase or wear anything purporting to have once belonged to a Bird of Paradise.

MARGARETTA L. LEMON.

Redhill, Surrey, June 21.

THE TICK PEST IN THE TROPICS.

THOSE living in temperate climates have probably small idea of the virulence of insect and other pests in the tropics. A plague of caterpillars may destroy a season's crop in England, but there is the winter's frost to be passed through before a second attack need be feared. It is otherwise in the tropics. Vegetation is much more luxuriant, and the food supply is permanent; and, when once a plague has obtained a firm foothold,

there is no apparent reason why it should cease its ravages before it has entirely destroyed its particular host. It is fortunate for agriculturists that the great increase of any particular parasite seems ultimately to work out its own destruction; and frequently when all hope seems over, the plague rapidly and unaccountably disappears.

Surprise has been expressed that ticks infesting cattle have received so little real study. Quite recently the statement appeared that these parasites formed the least known part of the tropical fauna. But a great deal has been done in this direction of recent years, and there seems some hope of real progress being made.

Taking the conditions into consideration, it is a matter of great wonder that so few ticks exist in many parts of the tropics. No real attempt has been made to decrease their numbers, and there appears to be no season of the year when the climate is fatal to them. Vegetation is rank, and we know now that they can live to a great extent upon vegetable matter; further, even where there is a scarcity of small indigenous mammals, there are plenty of horses and cattle. The multiplying powers of ticks are enormous. In one case I determined the number of eggs from one female as over 20,000 (see Fig. 3), and almost all of these were fertile and produced young ticks. The increase in numbers of ticks in most countries is not marked, however, and we are driven to the conclusion that there is here, in the animal kingdom, a waste of material analogous to that in the seeding of parasites and saprophytes among plants.

It is not surprising now and then to hear of a long-continued plague of ticks from one place or another where cattle-rearing is a staple industry. In Jamaica, it is by no means uncommon for the traveller to get covered with "grass-lice." On pushing aside the branches overhanging the riding path, I have been immediately covered with firmly attached young ticks which needed much care and patience to remove. The ticks of Jamaica are now a very serious source of anxiety in cattle-pens, and much loss is attributed to these parasites.

During my stay in Antigua, complaints were loud and frequent of the ravages of a large tick, which infested the cattle between the months of May and September. In the cattle and sheep farms of the Cape of Good Hope and Australia the "tick" matter is absorbing much attention. Specially large and annoying forms are described from parts of India, Central Africa and Central America; while extraordinary tales are told of the destruction caused by these parasites in cattle-rearing districts of South America. Elaborate and expensive researches have been conducted in the United States Southern Experimental Stations upon the life-history of the ticks and their relations to cattle; and the exhaustive reports, issued from the Bureau of Animal Industry, form by far the most valuable part of our economic literature on these pests.

The books of travellers teem with references to the annoyance caused by ticks. Sir Joseph Hooker, in his "Himalayan Journals," describes their abundance in the frontier regions between Sikkim and Nepaul, in pathless tracts destitute of animal life. He writes the following concerning the neighbourhood of Tonglo: "A large tick infests the small bamboo, and a more hateful insect I never encountered. The traveller cannot avoid these insects coming on his person (sometimes in great numbers) as he brushes through the forest; they get inside his dress, and insert the proboscis deeply without pain. Buried head and shoulders, and retained by a barbed lancet, the tick is only to be extracted by force which is very painful. I have devised many tortures, mechanical and chemical, to induce these disgusting intruders to withdraw their proboscis, but in vain."

Bates, on passing through the grassy lanes of the second-growth woods on the Amazons, often found himself covered by ticks. It occupied him, he says, a full hour after his day's work to clear himself of the parasites.

Belt refers to the "grass-lice" on the plains of Nicaragua, as quickly covering any one travelling through the country; so much so, that the herdsmen or "vacqueros" keep a ball of soft wax with which to rub themselves. The smaller ticks are thus removed from their skin, while the larger ones are picked off by hand.

Many a time, in walking through grass in the Leeward Islands, I have been conscious of the peculiar itching at the ankles caused by the attacks of "bête rouge." The bête rouge is not in reality a tick, although often confused with it. Horses seem to be particularly liable to its attacks, with the result that they lose all the hair about the face and eyes. In all probability the poor animals suffer a good deal, for the personal irritation is extreme. The bête rouge is exceedingly minute, and, as its name implies, is of a brilliant scarlet. At night, after retiring to rest, the warmth of the body seems to increase the irritation to the utmost pitch, and sleep becomes absolutely impossible. Rubbing or scratching the parts attacked merely intensifies the discomfort, the creature pushing itself deeper into the flesh. Most painful sores are the result if the greatest care is not taken. The one certain remedy seems to be to anoint the inflamed spots with vaseline. This substance not only soothes, but appears to destroy the bête rouge by stopping up its breathing pores. I have never succeeded in detecting the creature on the skin, but, when reading in or near an infested lawn, I have captured many by watching for the minute scarlet dots travelling over the white paper.

The damage done by ticks to cattle is undoubtedly very serious. According to observations by Leidy, the adult female tick is able to absorb 100 times its weight of blood, swelling during that time to an enormous extent. This food is rapidly changed into eggs. The adult male does not increase appreciably in size, but his demands upon the host have probably been greatly underrated. An account of tick-infested cattle in Queensland states that they were so completely covered that the branding-iron had to be burnt through the ticks before it was possible to reach the animals' skins. A case in Texas is mentioned where it was found impossible to lay a silver dollar upon the body of the animals without touching some ticks. Again in Texas, 100 full-grown ticks were collected from each ear of a pony, while many immature ones were left behind. The mere abstraction of blood must, in this case, be a very serious drain upon the system.

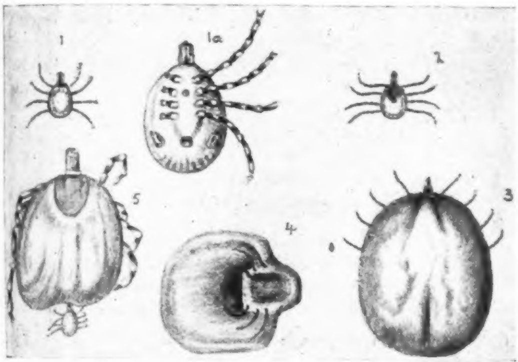
When one considers, further, the irritation experienced by travellers from the few ticks fixed upon them in their daily rambles, it may be safely concluded that the penetration of the countless proboscides into the skin of cattle must of itself be a source of great discomfort, especially as these animals are quite unable to get rid of them. Calves not uncommonly are destroyed by the formation of balls of hair in their stomachs; and in tick-regions this is undoubtedly due to an attempt to get rid of the parasites by licking and biting them off.

It is quite conceivable, then, that ticks do really cause the death of multitudes of cattle on the great estates where it is impossible to examine them closely. We should, however, approach this part of the subject with caution. Sickly cattle are usually covered by ticks, while the healthy ones have only a few; but it is questionable whether the ticks are the real cause of their emaciation. The case of ticks seems rather to be analogous to that of scale insects on plants. The latter pests appear in great quantities at any period of stress, when from lack of nutriment or other cause the plants become weakly. Thus, in Antigua, there is a marked disappearance of scale insects with the commencement of the rainy season. It seems probable that the prevalence of ticks upon certain cattle is rather due to conditions of the blood or skin of the animal, closely connected with its general nutrition. This is an exceedingly important matter for determination, for upon it, as will presently be shown,

depends the only means of freeing the cattle from these pests.

Thus far the direct effects of ticks upon cattle have been considered. Certain alarming facts have lately been brought to light with regard to the relations existing between ticks and different well-known cattle diseases. The subject is by no means new, having long been a fascinating one for cattle-breeders. The "louping-ill" or "trembling" of the north of Britain has been traced by some directly to the presence of ticks upon the sheep. The same may be said of a disease called "heart-water" at the Cape of Good Hope. Finally, the United States Department of Agriculture has for the last five or six years been conducting exhaustive experiments upon the connection between ticks and the Texas cattle fever, the results of which have appeared in the annual reports of the Bureau of Animal Industry already referred to.

There is, in this latter case, present in the blood of the cattle suffering from disease, an infusorian which quickly destroys the red blood corpuscles. This minute organism has also been detected in the body of the tick. It has been again and again transferred from diseased animals to healthy ones by means of the tick, and tick alone. The presence of this infusorian is regarded as diagnostic of



The Great Antigua Gold Tick.—*Hyalomma venustum*, Koch. (1) Mature male, natural size; colours, gold, scarlet, and black. (1*a*) Magnified ventral view. (2) Female, mature but not inflated; colours, shield black with flesh-coloured and gold spots; body dark green. (3) Female full of blood, natural size; colour, dark green. (4) The same female as in (3), after 20,000 eggs had been laid. (5) Female into which male had accidentally inserted his proboscis; both magnified.

the disease; and the effect of its corpuscle-destroying powers is seen all over the body, as well as in the red-coloured urine, which has won for the disease the colonial name of "red-water."

Ticks, then, are in certain cases connected with the transmission of deadly disease. In how many more cases this is so remains to be investigated. It is quite possible that some of the obscure cattle diseases in different parts of the world are caused by ticks, and that other countries will, in their turn, be forced to face this problem.

There is now and then an outbreak of a severe skin disease among cattle in Antigua; and this disease does not appear to be known in the neighbouring islands. Judging from the climate and peculiar conditions of Antigua, the scarcity of water and lack of nutritious food for part of the year might be considered sufficient to account for a local disease; but there is also a large tick present, which has not been recorded from the other islands of the group. A loose theory has thus arisen that this "gold tick" is connected with, if not the direct cause of, the cattle disease.

The evidence available does not tend to confirm this idea, but it is obviously impossible to solve the problem in the absence of proper appliances. I was led, however, to commence observations upon the gold tick, which may be of interest.

Mr. A. D. Michael has determined it to be *Hyalomma venustum*, which Koch described in 1847 from a single male specimen collected in Senegal. There is a local tradition in Antigua that the tick was introduced some thirty or forty years ago with some imported Senegal cattle; and this determination lends probability to the belief. The male is a very beautiful creature, decked in scarlet and gold, whence he obtains his name. The female is very large, one specimen being nearly an inch in length and weighing ·17 oz. I calculated the number of eggs laid by this female at over 20,000. She commenced laying on July 31, and finished, a shrunken mass, on September 10—a period of exactly six weeks. The accompanying life-size drawings are of Antigua gold ticks. The first is a mature male. He is not usually larger than this, and may be seen moving rapidly across the ground, or firmly attached to the skin of the cattle close to a female. The next three figures are of females, all mature, but at different stages. The first is undistended; the second gorged with blood, and commencing to lay its eggs; while the third is the same tick after the last egg was laid. There is also the drawing of a curious case, in which a male had by accident attached himself to a distending female—a mistake which resulted in the premature death of both.

The period of incubation observed in the tick's eggs varied from twenty-three to fifty-one days. The young ticks usually emerged in great numbers on the same day, and any eggs left unhatched quickly dried up. In Antigua the gold ticks appear upon cattle, in numbers, from May till September each year. It became important to determine what became of them in the meantime; and whether they passed the winter in the body of the parent, in the egg, or as young ticks. From experiments in the laboratory, it would appear that the little ticks pass the winter months huddled together in masses of several hundreds at the roots of the old dead grasses.

In considering the remedies for ticks, one is soon forced to the conclusion that direct measures against the parasite themselves will be of little avail. Methods of prevention are always preferable to those of cure, and in no case is this more so than with parasites of this class. Besides this, they are practically invisible at the most dangerous stage; and when we see the ugly, swollen, mature specimens, we know that their evil work is done. All large females should be carefully collected and burnt, however, as thus future attacks will be diminished.

The treatment of pastures is a very important matter. Here probably the parasite spends the greater part of his early life—usually on the ragged bunches of old grass left from previous years. The proper feeding or cutting of the grass, and the liming and draining of the pastures, will destroy myriads of the infant ticks or "grass-lice." For the sake of the animals, there is every inducement to render the pastures as nutritious as possible; and ticks do not seem to trouble the sleek cattle of the herd. It is an undoubted fact, moreover, that the improvement in food, due to change of pasturage, does in certain cases cause all the ticks to drop off infested animals. The first class of remedies will aim at cutting off the supply of ticks by treating the pastures.

The second class—one might say almost the only one which is attempted in the tropics—is the destruction of ticks upon the cattle.

The common method of tying the legs of the animal together, hurling it to the ground, and smearing some tick-destroying compound over it, cannot be too strongly condemmed, especially as there is no need for it whatsoever. Cattle may be handled with impunity if some form of cattle-bail is employed; by this means they may be driven one by one into a small trap, where they

can be treated. But even this is hardly necessary if the application to the skin is in the liquid form; for with a powerful spraying machine, as many as one hundred cattle have been completely covered in the space of an hour.

Of pastes and powders and fluids recommended there is no end; and it will serve no useful purpose to give detailed lists discussing the merits of each. The points to be kept in view are that the liquid should be of an oily and non-poisonous nature, capable of clogging up the air-pores of the ticks. It should be cheap, and easily applicable without handling the cattle; it should, finally, not easily evaporate, or be washed off by the rains. A full discussion of remedies has recently been published by me, the following being taken from the summary at the end: "A number of types of washes for spraying are selected for description. All poisonous ones should be rejected, as there are non-poisonous preparations equally effective. Carbolic acid dips and other liquids, which evaporate quickly, need frequent applications, and should be discarded in favour of oily liquids or emulsions where the latter are equally effective. The best of all these is the kerosene emulsion regularly used for plants. There are many formulæ for the preparation of this; a useful one (for ticks) is given." The formula referred to is as follows: "In two quarts of boiling water dissolve half a pound of soap; remove from fire; immediately add one pint of kerosene, and agitate. In from three to five minutes the liquid becomes creamy. It may be stored in this form in bottles or barrels. For use, add three of water to one of emulsion; mix thoroughly, and apply with a spraying pump." [1]

The third and most important class of remedies is closely connected with the nutrition of the animal. If we can render the skin or blood of our cattle so distasteful to the tick that the latter will not attach itself, we have a solution of the whole matter. We should confer immunity upon our animals, and, at one stroke, do away with the necessity of all the laborious and expensive methods now in vogue for the destruction of these parasites.

The first step in this direction has been taken; and, in various parts of the world, most excellent results are recorded from the addition of small doses of sulphur to the animal's food.

It has already been noted that the food of animals has an influence upon their infestation by ticks. Cases are not uncommon among cattle-breeders where a mere change of pasture will cause all the ticks to drop off. This change is obviously felt through the animal's skin.

It has also been mentioned that the ticks seem to congregate upon cattle in poor condition, while those with sleek skins are more or less untouched. Dr. Cooper Curtice (late of the United States Bureau of Animal Industry) suggests, as an explanation of this, that there is in well-fed cattle an oily condition of the skin obnoxious to the ticks; and this suggestion is the more worthy of consideration when we remember the aversion of these creatures to grease of any kind.

It is certain that *sulphur taken internally* will render the skin evil-smelling, by the exhalation of sulphuretted hydrogen, a substance highly obnoxious to all parasites. The following seem to be the physiological changes which take place during the passage of the sulphur through the animal's body to the skin. Sulphur taken in with the food passes the stomach unaltered. In the intestines a small portion is changed into sulphides of hydrogen and the alkalies. Part of these sulphides pass into the blood, and into the tissues from the blood, and act chiefly upon the central nervous system. The sulphides in the tissues are variously excreted. By the kidneys they are excreted as sulphates; if in excess, part is also excreted in the form of sulphides. By the skin they escape as sulphides, giving the characteristic foul odour to the perspiration, and somewhat increasing its amount.

[1] For further details, see papers in Leeward Islands *Agricultural Journal*, Nos. 1-3.

The doses of sulphur should be small, but they should be constant. The form in which the medicine is offered to the animals will best be decided by the manager of the estate. With stall-fed cattle there can be no difficulty at all; but with the cattle of large estates, which are seldom handled and sometimes not seen for long periods, it will be necessary to prepare the sulphur with salt as a "lick," to which cattle will readily help themselves if it is scattered about.

The success of this sulphur treatment has so far been encouraging, both at the Cape of Good Hope and in the United States. Doubtless with continued study other similar preventive remedies will from time to time be discovered, and thus rid the stockowners of the tropics of one of their most dreaded enemies.

C. A. BARBER.

NOTES.

PROF. HUXLEY'S health is at present a source of great anxiety to his friends. Symptoms of renal insufficiency appeared last week, and this, with the other complications which have attended his protracted illness, has made his condition a very critical one, but we are glad to learn that it is improving.

WE deeply regret to notice the announcement of the death of Dr. W. C. Williamson, Emeritus Professor of Botany in Owens College, Manchester. Dr. Williamson was elected into the Royal Society in 1854.

PROF. VERNEUIL, the eminent French surgeon, and Member of the Paris Academy of Sciences, died on June 12.

PROF. SIMON NEWCOMB has been elected Associé étranger of the Paris Academy of Sciences, in succession to the late von Helmholtz.

PROF. W. PETERSON, Principal of the University College, Dundee, has accepted the position of Principal of McGill University, Montreal, in succession to Sir William Dawson.

SIR E. MAUNDE THOMPSON, principal librarian of the British Museum, has been elected a Corresponding Member of the Philosophico-historical Section of the Berlin Academy of Sciences.

THE University of Pennsylvania has received gifts, within a few days, aggregating nearly a million dollars. This includes half a million dollars from Provost Harrison, already noted in these columns. Scarcely a week passes without our being able to record similar gifts from private benefactors to the universities and colleges of the United States. *Science* reports that Dr. D. K. Pearson has offered £10,000 to Mount Holyoke College if an additional £30,000 can be raised. It is said that Dr. Pearson has already given £400,000 to various colleges.

THE death is announced of Dr. A. Eliseief, known for his explorations and anthropological work.

THE St. Petersburg correspondent of the *Lancet* reports that the Emperor of Russia has appointed a committee to organise the collection of subscriptions for the monument which the Institute of France propose to erect to Lavoisier.

THE trustees of Columbia College decided, a few days ago, to grant the Barnard Medal to Lord Rayleigh and Prof. Ramsay jointly for their discovery of argon. Only Lord Rayleigh's name was mentioned in the previous announcement of the award.

DR. BACKLUND has been elected a Correspondant of the Paris Academy, in the Section of Astronomy, in the place of the late

M. Wolf; and Prof. Kowalewsky has been elected to fill the late M. Cotteau's place as Correspondant in the Section of Anatomy and Zoology.

THE French Association for the Advancement of Science will meet at Bordeaux, from August 4 to August 9, under the presidency of M. E. Trélat. Applications for membership should be addressed to the Secretary of the Association, 28 rue Serpente, Paris.

THE third international meeting of Psychologists will be held at Munich from August 4 to 7. The first meeting was held at Paris in 1889, and the second in London in 1892. Prof. Stumpf, of Berlin, will act as President, and Dr. von Schrenck-Notzing, of Munich, as General Secretary.

The second Italian Geographical Congress will be held in Rome next September, under the patronage of the King of Italy and the Duke of Genoa. The President of the Congress will be Marquis G. Doria, President of the Societá Geographica Italiana. The Secretary is Prof. D. Vinciguerra, and his address is Via del Plebiscito, 102, Roma.

DR. T. G. BRODIE has succeeded Prof. C. S. Sherrington, F.R.S., as Lecturer on Physiology at St. Thomas's Hospital.

PROF. E. HERING, of Prague, has been proposed as successor of the late Carl Ludwig in the chair of Physiology at Leipzig.

PROF. E. MACH, of Prague, well known by his book on Mechanics, and by his experimental researches on Physics, has been appointed Professor of Philosophy at the Vienna University. Vienna will, therefore, be the first place where Philosophy will be taught on a modern and scientific basis.

THE Cracow Academy of Sciences offers prizes of 1000 and 500 florins for the best discussion of theories referring to the physical condition of the earth, and for the advancement of an important point connected with the subject. Memoirs must be sent in before the end of 1898.

THE International Conference on the Protection of Wild Birds met at Paris on Tuesday, under the presidency of M. Gadaud, Minister of Agriculture. England was represented by Sir Herbert Maxwell, Mr. Howard Saunders, and Mr. F. Harford, of the British Embassy at Paris. Belgium, Holland, Germany, Russia, Austria-Hungary, Luxemburg, Switzerland, Italy, Greece, and Spain have also sent delegates. The conference meets as the result of a resolution passed at the International Agricultural Congress held at the Hague in 1891.

AT the recent annual meeting of the Royal Society of Canada, the following officers (says *Science*) were elected for the ensuing year:—President, Dr. R. S. C. Selwyn, C.M.G., F.R.S.; Vice-President, the Archbishop of Halifax, Dr. O'Brien; Secretary, Dr. J. G. Bourinot, C.M.G.; Treasurer, Prof. J. Fletcher. Prof. Bovey, Dean of the Faculty of Applied Science, McGill University, was chosen President of the Section of Mathematical, Physical, and Chemical Sciences, Prof. Dupuis, Vice-President, and Captain E. Deville, Surveyor-General of the Dominion, Secretary. In the Section of Geological and Biological Sciences the following choice was made:—President, Prof. Wesley Mills; Vice-President, Prof. Penhallow; Secretary, Dr. Burgess.

AT the annual general meeting of the Numismatic Society of London, held on Thursday last, Sir John Evans, President, in the chair, the silver medal of the Society was awarded to Prof. Theodor Mommsen, for his distinguished service to the science of Numismatics. Dr. Barclay Head, keeper of coins in the British Museum, in returning thanks on behalf of Prof. Mommsen, drew attention to the fact that quite recently Mommsen had handed over to the Royal Academy of Sciences of Berlin the sum of 25,000 marks, presented to him as a testimonial from his disciples in all countries on the occasion of the jubilee of his Doctorate, with directions that it should be devoted to the compilation and publication, under the auspices of the Academy, of a complete *corpus* of all known extant Greek coins.

FEW neighbourhoods offer more features and objects of interest than the district around Galway. An excursion to this district, arranged by the Irish Field Club Union, will therefore probably be a very successful one. The country west of Galway presents the geologist with a great variety of rocks and rock structures. Some of the most interesting studies in Ethnography afforded in the British Isles may there be found, and the antiquarian and archæologist are offered exceptional attractions. The party will meet at Galway on Thursday, July 11, and will stay in the neighbourhood until the following Wednesday. The places to be visited are: The Twelve Bens, Connemara, Ballyvaughan and the Burren district, the Aran Islands, Oughterard and Lough Corrie. A programme, containing notes on the topography, geology, botany, zoology, ethnography, and archæology of these places has been prepared. During the reunion, a conference will be held for the consideration and discussion of matters relating to the advancement and extension of Field Club work in Ireland. The Secretary of the Union is Mr. R. Lloyd Praegar, National Library, Dublin.

IT has long been known in a general way that the time required for hatching out the eggs of cold-blooded animals is dependent on the temperature at which they are kept; and that in the case of birds "the period of incubation is much related to the size of the bird." Mr. A. Sutherland (Roy. Soc. of Victoria, December 1894) has recently made some observations on the relations between hatching-time and temperature, and formulates a law based upon his results. He has further investigated incubation among birds and gestation. Birds and mammals keep at a practically constant temperature—between 37° C. and 43° C.; and it may be assumed that sitting birds keep their eggs at a tolerably definite temperature. Why then should the period of incubation or gestation vary so much? Mr. Sutherland asserts that the time of incubation or gestation, as the case may be, has a certain definite relation to the weight of an animal. He states the two laws he has arrived at in the following words:—(1) "For animals of the same size the time of embryo development is inversely proportional to the square of the temperature, that temperature being reckoned from a definite point." (2) "At the same temperature, the period of development is directly proportional to the sixth root of the weight of the mature animal."

A FEW months ago, M. de Montessus published an interesting paper on the frequency of earthquakes, of which a summary is given in a previous note (vol. li. p. 540). This he has followed up by another paper of still greater value on the relation between seismic frequency and the relief of the ground (*Comptes rendus*, vol. cxx. pp. 1183-1186). The following are the general conclusions at which he has arrived from a study of 348 regions, in which 9700 earthquakes and 5000 volcanic eruptions are known to have occurred. In a group of adjoining districts, the most unstable are those which present the greatest differences of relief, *i.e.* those whose average slope is greatest. The unstable regions follow the great lines of folding of the earth's crust. Mountainous countries are generally more unstable than flat ones, and, in any one mountain-chain, the

short and steep slope is the more unstable of the two, especially in its steepest parts. Coast regions with a rapidly deepening sea are unstable, especially if bordered by an important mountain-chain; those with a slightly sloping sea-bed are stable, especially if they adjoin a flat country. Lastly, in regions which are frequently disturbed by earthquakes, and which at the same time possess very active volcanoes, the seismic frequency and volcanicity are independent. It follows, therefore, that earthquakes are a purely geological phenomenon, and probably have their origin in the same dynamical forces to which the present relief of the earth's crust is due.

Radiolarian earth of Tertiary age has long been familiar from Barbados: in a recent number of the *Bull. Museum Comp. Zool.* (Harvard), Mr. R. T. Hill records it from the island of Cuba. It occurs at one place only, near Baracoa, where it is over 500 feet in thickness and is well stratified, the strata being vertical. The rock is chalky in appearance, with occasional thin separation-layers of a grey-blue clay, and some flint-like siliceous nodules: sponge-spicules and echinoid fragments were found in it, but no diatoms It appears to lie below certain yellow beds identified as Miocene. The paper contains much other information on the geology of Cuba, and the origin of the circular harbours of the north coast is dealt with. The author finds no evidence of any movement of depression in the island since the beginning of Tertiary times.

Dr. F. Klengel, of Leipzig, has sent us a copy of his paper, read some time since before the Bohemian Society of Sciences, on the non-periodical variations of temperature in the district of the Pic du Midi and Puy de Dôme, compared with those at St. Bernard, for which station a longer series of observations is available. The problem undertaken by the author was mainly to show how far the irregular variations of temperature in these three widely separated and high regions of Central Europe agreed together. The most important conclusions drawn from various tables are, that a remarkable agreement is shown in the non-periodical changes at the mountain stations, whereas in the plains the variations differ materially from each other. The influence of the sea is visible in the lower region of of the Pic du Midi, but at the higher level it entirely disappears.

The papers in the June *Journal* of the Royal Microscopical Society include one on British patents taken out in connection with the microscope, between 1666 and 1800.

The Department of Mines ot Victoria has issued a report on the Victorian coalfields, the development of which is proceeding rapidly. Evidence is given to show that the coal is of drifted origin: among other points, the mixture of conifers and ferns in the flora can only be explained by transport before deposition.

Mr. John Tebbutt has sent us a report of the work done at his observatory, Windsor, New South Wales, during 1894. Meteorological observations have now been made at the observatory for thirty-two years. Among the astronomical work of last year were observations of lunar occultations of stars, of southern comets, and of double stars.

The sixty-first annual report of the Natural History, Literary, and Polytechnic Society of York School gives evidence of enthusiastic work in many branches of science. Few school societies of a similar kind can boast of reports running into the sixties. With this report we received the *Natural History Journal* and *School Reporter* for June 15, conducted by the societies in Friends' schools. The journal contains articles on Southern Tyrol and on the planet Mars, as well as notes, and records of observations of scientific interest.

Bulletin No. 48 of the U.S. National Museum is devoted to "A Revision of the Deltoid Moths," by Prof. John B. Smith, the paper being a contribution towards a monograph of the insects of the Lepidopterous family Noctuidæ of Boreal North America. Fourteen plates, showing the different species of these Noctuids, and the structural characters of the Heliini, Herminiini, and Hypenini, accompany the descriptive text. The genera Pseudorygia and Rivula are not included in the series, Prof. Smith being of the opinion that they do not possess real Deltoid characteristics.

The Report of the Geological Survey of Canada for 1894 describes the results of geological expeditions in the Labrador Peninsula and west of Hudson Bay. In consequence of lack of money it was found necessary to reduce the number of parties working in the field, while there is an accumulation of material awaiting publication. A deep boring for petroleum has been begun at Athabasca Landing, but at a depth of 1011 feet the oil had not been reached; all indications, however, point to the existence of great quantities of petroleum in the Devonian strata which immediately underlie the Cretaceous.

The Central Physical Observatory of St. Petersburg has made an important addition to its comprehensive *Monthly Weather Report* by showing on a chart the deviations of temperature and rainfall of the month from the normal conditions. To arrive at this, M. Wild states that the values have been calculated for no less than 322 stations, all of which are represented in the report. The excess or defect of temperature at each place is shown on the chart by drawing curves through those places where the deviation is equal in amount, while the deviation of rainfall is represented by red and blue tints. The work is very neatly executed, and shows clearly, at a glance, the climatic conditions of the month.

The 1895 *Photography Annual*, edited by Mr. Henry Sturmey, is an invaluable compendium of photographic information, and a useful record of the progress made during last year in the various branches of the science and practice of photography. In it Mr. C. H. Bothamley traces the advances of photographic chemistry; Mr. Chapman Jones describes the work done in the field of photographic optics; Mr. T. Bolas records the progress made in photo-mechanical printing; Captain Abney writes on spectrum photography; and Mr. Albert Taylor contributes a very full account of what was done in astronomical photography during 1894. These records, together with descriptions of new photographic apparatus and materials, technical articles, and particulars of photographic societies throughout the United Kingdom, render the *Annual* indispensable to all who take an intelligent interest in photography. The publishers are Messrs. Iliffe and Son.

The current number of the *Comptes rendus* contains an account, by M. Berthelot, of a new combination of argon. Following up his researches on argon, this author has discovered that free nitrogen, prepared pure from nitrites, can be caused to enter into combination with the elements of carbon disulphide when subjected to the spark or silent discharge after saturation with disulphide vapour. The resulting compound contains some mercury sulphocyanide, and does not regenerate nitrogen under the action of heat or of concentrated sulphuric acid. When argon is employed in place of nitrogen, a similar reaction appears to take place. Under the continued action of the silent discharge, a sample of 6·55 c.c. of argon, as pure as it could possibly be obtained, saturated with carbon disulphide vapour

at 20° C., and confined in the reaction tube by mercury, gave a continuous absorption which appeared to go on indefinitely. The product contained mercury, but gave no reaction for sulphocyanide. When heated, a quantity of gas was recovered equal to about one half the volume absorbed, and this recovered gas was proved to be argon by condensation with benzene, and production of the remarkable fluorescence previously described. Though this work has been done on such small quantities of material that an exhaustive examination of the product was not possible, M. Berthelot believes that he has satisfactorily demonstrated the significant property of argon, that it can enter into combination and be regenerated from its compound or compounds with its initial properties intact.

As a result of observations carried on by the *Investigator* in the autumns of 1892–3–4, Commander C. F. Oldham, R.N., contributes two papers on the Laccadive Islands to the *Journal of the Asiatic Society of Bengal* (vol. lxiv. pt. ii. No. 1, April 1895). The group consists of four submerged coral-reefs, six reefs with small islets ("sand-cays"), and eight inhabited atolls: three of the reefs and five of the atolls were examined. The islands and sand-cays occur, in all cases but one, on the eastern side of the atolls; they cannot, therefore, have been built up by the action of the ordinary monsoon winds which blow mainly from the west, but must be due to the occasional hurricanes which reach the eastern and north-eastern sides of the atolls. The effect of the tides and currents is seen in the more vigorous growth of the atolls to the south and west. The islands and islets are extending at their extremities, and in some cases are being added to on the south-western sides where they face the lagoon. No evidence of either elevation or subsidence was observed.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. Stevens; two Javan Parrakeets (*Palæornis javanica*) from Java, presented by Lieut.-General Sir H. B. Lumsden; a Green-winged Trumpeter (*Psophia viridis*) from Brazil, presented by Mr. H. A. Astlett; a Diamond Snake (*Morelia spilotes*) from Australia, presented by Mr. M. Mitchener; a Natal Python (*Python natalensis*) from South Africa, presented by Mr. William Norman; a Korin Gazelle (*Gazella rufifrons*, ♀) from Senegambia, a Blue and Yellow Macaw (*Ara ararauna*) from South America, a Naked-necked Iguana (*Iguana delicatissima*) from Tropical America, thirty-four Black Salamanders (*Salamandra atra*), South European, deposited; a Tachiro Goshawk (*Astur tachiro*) from South Africa, nine Red-beaked Weaver-Birds (*Quelea sanguinirostris*) from West Africa, purchased; a White-crested Jay Thrush (*Garrulax leucolophus*), a Striated Jay Thrush (*Grammatoptila striata*) from India, received in exchange; a Burrhel Wild Sheep (*Ovis burrhel*, ♀), a Patagonian Cavy (*Dolichotis patachonica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE YERKES OBSERVATORY.—From a note in the *Astrophysical Journal* for June, we learn that the construction of the buildings of the Yerkes Observatory is advancing rapidly, and it is hoped the 40-inch refractor will be ready for use in September or October. The Observatory is situated on the shores of Lake Geneva, Wisconsin, at an elevation of 180 feet above the lake, and is about seventy-five miles from Chicago. The dome for the great telescope, which is being built by Warner and Swasey, is 90 feet in diameter, with a shutter opening 12 feet; the rising floor is 75 feet in diameter, and will have a vertical movement of 22 feet. The motive power for turning the dome and elevating the floor of the Observatory will be supplied by electro-motors.

In addition to the large telescope, provision is made for the use of the 12-inch telescope now at the Kenwood Observatory, and another telescope of 16 inches aperture. The meridian room is designed to accommodate a large meridian circle, but, in the first instance, a transit instrument will be employed.

The Observatory buildings appear to be designed on a very liberal scale, and comprise offices, library, lecture theatre, spectroscopic, physical, chemical, photographic, and other laboratories. We understand that Prof. Barnard and Prof. Burnham have accepted positions in the Observatory.

THE GRANULATION OF THE SUN'S SURFACE.—The granular or mottled appearance of the surface of the sun is familiar to all observers, and the great resemblance to terrestrial cirrus clouds has long been recognised. A possible cause of this appearance has been recently suggested by Dr. Scheiner (*Astr. Nach.* 3279), the idea being that Helmholtz's investigations on the formation of waves in our own atmosphere apply also in the case of the sun. According to Helmholtz, air waves are produced when two strata of air of different temperature and density glide over each other; if the lower layer is nearly saturated with aqueous vapour, the wave crests will be centres of condensation, in consequence of diminished pressure, and will appear as clouds, while the depressions will form transparent interspaces. On this theory a "mackerel sky" is produced when two series of waves cross each other. Dr. Scheiner points out that somewhat similar conditions prevail in the sun; there are layers of different temperature, and currents in various directions in these layers, and in the photosphere the condensable gases are in an over-saturated state. He therefore considers that the bright grains of the photosphere are wave-crests of two crossing systems of waves, rendered visible by an increase of condensation. In the case of the sun, the observed lengths of the waves—that is, the distance between the separate grains—is from 1000 to 3000 kilometres, and it is believed that waves of this magnitude might be produced without the assumption of extraordinary velocities.

Assuming this to be a true explanation, the photosphere must be a very thin layer; and since the granules are of about the same size in all parts of the surface, the velocity of the currents must be nearly equal in all heliocentric latitudes.

THE SATELLITES OF JUPITER.—Not contented with his brilliant discovery of a fifth satellite to Jupiter, Prof. Barnard has been employing the great resources of the Lick telescope in further investigations of the satellites which were discovered by Galileo (*Monthly Notices*, *R.A.S.*, vol. lv. p. 332). One part of his work has consisted of micrometric measurements of the diameters of the satellites, and the results, reduced to a mean distance of the planet from the sun equal to 5·20, are as follows:

	Angular diameter. ″	Diameter in miles.
Satellite I.	1·048	2452
,, II.	0·874	2045
,, III.	1·521	3558
,, IV.	1·430	3345

It is pointed out that these values are in good accordance with the mean values derived from nine sets of measures made by as many different observers since 1829. Of the earlier estimations, those made by Schroeter in 1798 agree most closely with modern results.

Special attention appears to have been given by Prof. Barnard to Satellite I., on which he discovered, with the 12-inch equatorial, on September 8, 1890, the existence of a bright equatorial belt and dark polar caps. These appearances have been verified at every favourable opportunity, and "they are, beyond question, permanent features of the satellite, and will always be visible when a favourable transit occurs." These markings on the satellite fully account for all the phenomena which have been reported of the distortion or ellipticity of its disc, as well as for the apparent doubling of the satellite during some transits. When the satellite is transiting over a dark part of the planet, the white belt appears very prominently, while the dark poles are correspondingly difficult to see, so that, without very close attention, the satellite looks like a thin white strip. If, on the other hand, it be transiting across a bright part of the planet, the white belt is lost in the bright background, and the polar regions appear as two separate dark spots, making the satellite appear double. The dark polar caps are darkest at the poles, and become rapidly less intense towards the equator. Prof. Barnard considers that the phenomena observed on this satellite indicate that its physical condition is similar to that of Jupiter.

THE SUN'S PLACE IN NATURE.[1]

VII.

AT the end of the last lecture, some evidence was brought forward which leads to the conclusion that in those stars in the spectrum of which bright lines are seen, we are dealing with bodies closely associated with nebulæ. It was at once suggested that possibly by those new methods of inquiry to which I have already referred, we might be enabled to demonstrate the existence of the nebulæ, although we can never hope to see them by the unaided human eye. The idea occurred to me that long exposed photographs might give us stars surrounded by nebulæ. So I wrote to Dr. Roberts, who always kindly places himself at the disposal of any student, and asked him if he would be so good as to photograph that region of the heavens in which most of the bright-line stars have been observed. He at once acceded to my request, and took photographs, as desired, with his instrument, giving an exposure of three and a quarter hours. The result a little disappointed me, because he reported that there was no indication whatever of any nebulosity surrounding these stars. Possibly it was on this account that Dr. Huggins felt himself justified in objecting to the view which associated these stars with nebulous surroundings. But that is not the whole story. Some time afterwards, at the request of Mr. Espin, Dr. Max Wolf, who has an instrument which is even more competent to pick up faint nebulæ than the wonderful telescope employed by Dr. Roberts, also took photographs of this same region; and I need not tell you that, being anxious to carry the inquiry as far as he could, he made the exposure what we should consider almost impossibly long—so long, in fact, that one whole night was not sufficient. His first photograph of this region was exposed for thirteen hours on three nights; the next one was exposed for eleven hours. Now I will throw on the screen the result which was obtained by Dr. Wolf with the instrument which at the present moment is the most competent to give a verdict upon such inquiries as this. Here, in the first instance, we have a photograph of the region surrounding the brightest star in the constellation Cygnus, and you will observe that we have here and there indications of nebulous matter as well as of stars. That is rendered evident by the fact that in certain other regions we get a perfectly flat background, whilst in this the background itself is luminous. Now we come to the region in which these bright-line stars have been recorded for several years, and you see it is almost impossible to point out in this photograph a large area in which there is not a most obvious indication of this luminous nebulosity. Patches here and there seem to indicate that the great differentiation between this part of the sky and others, lies not in the wealth of stars, but in the wealth of the luminosity in which they are situated.

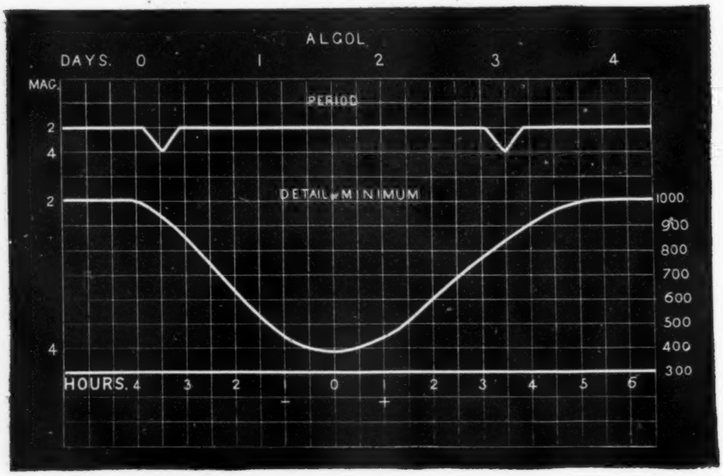


FIG. 29.—Light-curve of Algol.

It was obvious therefore, from this experiment, that I was perfectly justified in stating that these bright line stars were associated with nebulæ, since we find the statement made on theoretical grounds now backed up by these exquisite data, which indicate that most certainly there is a complete association of nebulous matter with these stars.

I do not want to part with that diagram until I have pointed out to you the enormous advantage students of science now have in possessing such magnificent photographs as these. Not only is the wealth of science rendered obvious, but the wealth of nature. Here, you see, is what modern science makes of a little patch of the sky on which the naked eye sees nothing at all.

The conclusion is therefore this: there seems to be no doubt that bright-line stars are directly connected with nebulous matter. I am glad to add that this is also the conclusion of the American astronomers who have inquired into the subject.

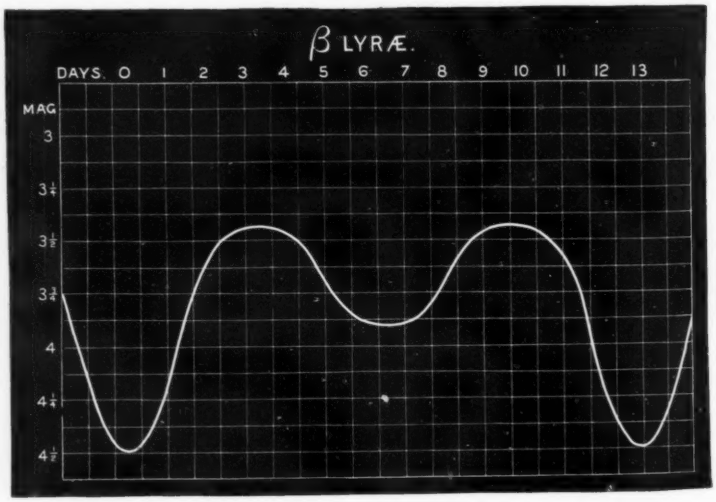


FIG. 30.—Light-curve of β Lyræ.

The next point in the meteoritic hypothesis—that some of the heavenly bodies are increasing, others diminishing their temperature—is one which I have brought out in that strong form, but I do not propose to say very much about it to-night. You may remember what has been said with reference to the hypothesis of Kant and Laplace, and especially Laplace's view that in the nebulæ we have to deal, as also in the stars

[1] Revised from shorthand notes of a course of Lectures to Working Men at the Museum of Practical Geology during November and December, 1894. (Continued from page 158.)

associated with them, with gases at a very high temperature. Now, in the hypothesis which I have ventured to put before the world of science, I differ in this particular both from Laplace and also from Vogel, who has most industriously attempted to establish a classification of the celestial bodies. I pointed out that in accordance with thermo-dynamical principles, the temperature must increase with condensation, and of course it will depend, therefore, upon the condensation of the gas, whether we have to deal with high or low temperatures in the bright-line stars and the nebulæ. I wish to take this occasion to state that Prof. Darwin has recently shown, as the result of a most profound inquiry, that swarms of meteorites in space will behave exactly like a gas; therefore, what can be said of the thermo-dynamics of a gas may be said also of the thermo-dynamics of a meteoritic swarm.

Now we come to a very interesting part of the inquiry, because it lands us among phenomena which so far have been considered to be exceptional. I refer to the phenomena of the so-called variable stars. You will see in a moment that if there is any truth in what has been brought before you, the light of stars as they pass from the nebulous to the more luminous stage must change during the progress of that evolution. But remember, that change will not be visible to one generation of men, probably not to a thousand generations of men. It is a change which will require millions, and possibly billions, of years for its accomplishment; and therefore we must not associate the word "variable" with any change which depends wholly upon the evolution of these various stellar conditions. But in addition to that, we can see almost in hours, certainly in days, frequently in months, sometimes in years, changes in the light of certain stars; and it is these short period changes which mark out and define for us the phenomena of variable stars.

Take a star like the sun. It is pretty obvious to you that any change in the sun, such as we see it now, would require a very considerable time for its accomplishment, so as to be obviously visible to us all; but if you take two bodies like the sun, you might imagine a condition of things in which one body would come exactly in the line between the earth and the other body, and would so eclipse the further one. There you have at once the possibility of an eclipse due to the passage of one body in front of another, and therefore of a variability which depends upon eclipses. So much for two bodies like the sun; but we know that in various parts of celestial space some of the stars have run through their life of light, and exist as dark bodies. Obviously we should get the same eclipse phenomena when dealing with one star like the sun and another dark body, provided always that the dark body came and eclipsed the light one. That is a very well known and accepted cause of variability, and one of the most obvious cases of this kind we have in the star Algol. There we have two bodies, a bright and a dark one, and a diagram will give us what is called the light-curve, the curve indicating the variability brought out by such a condition as that I refer to. When we come to examine the light-curve of a body like this, we find that the luminosity of the star remains constant for some considerable time in relation to the period of variability, and then it suddenly decreases. It almost at once—in an hour or two—goes up again, continues then for another period, and suddenly diminishes again (Fig. 29).

Spectroscopically we can inquire into the question as to whether there is or is not any physical change connected with this. Obviously, if it is merely an eclipse, there should be no physical change, and therefore no change in the spectrum. Here, by the kindness of Prof. Pickering, I can show you two photographs of the spectrum of this star, when it is most luminous, and when it is least luminous, and the spectra of these two conditions are, you see, quite similar. The broad lines are alike; in other dark lines also there is no change. Therefore, spectroscopically, we are justified in saying that the theory that variability is caused by eclipses is a perfectly justifiable one.

But supposing we consider no longer two bodies like the sun, or even one sun and another body more condensed and colder than the sun, but two not completely condensed meteoritic swarms; various probabilities never before considered will lie open to our inquiry.

We may take the remarkable case of variability presented to us by one of the brighter stars in the constellation of the Lyre, β Lyræ. The spectrum of that star has been very carefully studied, and if you will look at the details now on this diagram, you will see a series of the most marvellous spectral changes showing at once that we are not in the presence of phenomena at all similar to those presented in the last star examined. Fig. 30 shows the light curve of β Lyræ, which when at its lowest brightness is a $4\frac{1}{2}$ magnitude star, and at its greatest brightness is a $3\frac{1}{2}$ magnitude star, the changes going through one magnitude. In this scale you see that the changes are run through in a period of thirteen days. From the period of the greatest obscuration of

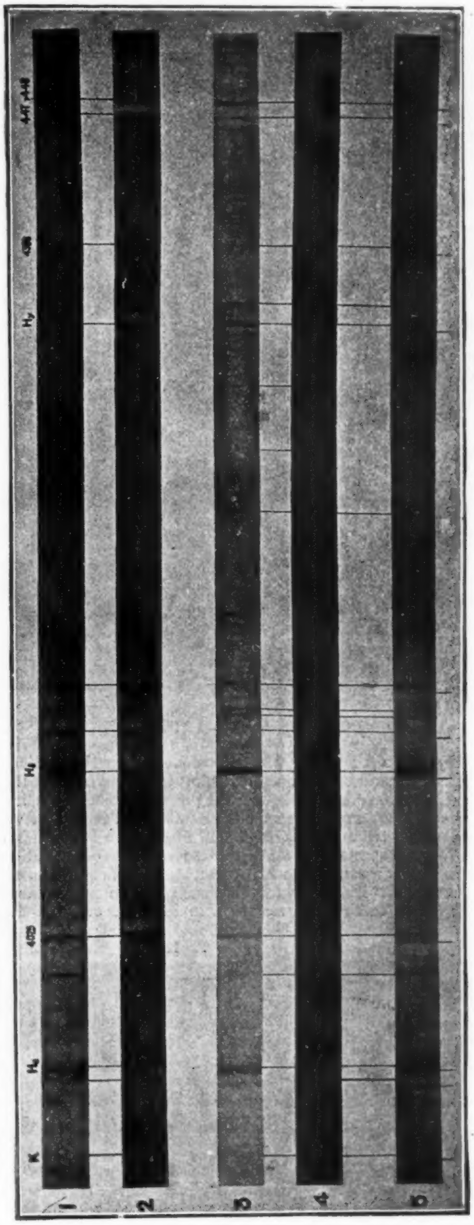


FIG. 31.—Spectra of β Lyræ (2, 3, 5) compared with Bellatrix (1) and Rigel (4).

light, in nearly three days we get to the highest luminosity, then at the sixth day we get to what is called a secondary minimum, *i.e.* the light has gone down a bit, but not so much as it had done at the beginning of this light cycle; then it goes up again, so that on the tenth day we get a maximum of light such as we had on the third day; after that it goes down, so that on the

thirteenth day, or thereabouts, we get to another minimum, and then the cycle begins again. Associated with these changes we have considerable changes in the spectrum. We have been fortunate enough to get a spectrum of this marvellous star for every day included in this period of change, although of course the photographs have not been taken in a period of thirteen days or in ten periods of thirteen days; but by knowing this period, we have been able to place the different photographs together so as to see exactly what happens. We get bright lines and dark lines, and bright lines changing their places; but the main point we have been able to make out so far, is that we are dealing with two stars very much like a number of stars that we see in the constellation of Orion. In Fig. 31 we have photographs of the spectra of two of the stars in the constellation of Orion, and associated with them, three photographs of the spectrum of β Lyræ; from the change in the position and coincidence of these lines we are able to make out that the variability of β Lyræ is produced by the revolution round each other of two stars like certain stars in the constellation of Orion, and that part of the light is probably cut off by some kind of eclipse; also that a certain amount of light which writes out for us these bright lines is produced at a certain part of the light curve. The photographs show that about the time of principal minimum, the dark line spectrum of β Lyræ (2) is very similar to that of Bellatrix (1), while about the time of secondary minimum the spectrum of β Lyræ (3) becomes more like that of Rigel (4), the differences at these times being mainly in the intensities of the lines. The photograph of the spectrum about the time of second maximum (5) shows that there are two spectra displaced with respect to each other. The spectrum displaced to the less refrangible side is shown to resemble that of Rigel, while that displaced to the more refrangible side closely resembles Bellatrix. I do not profess for one moment to imagine that all the conditions of variability in that star have been thoroughly explained, but we know enough to say that it is something quite different from the condition which obtains in such a star as Algol. Also, from the fact that we are dealing with stars like those in Orion, we know that we have to do with more or less condensed bodies, bodies not so condensed as the sun is, but still condensed enough to be called stars without fear of making any great mistake.

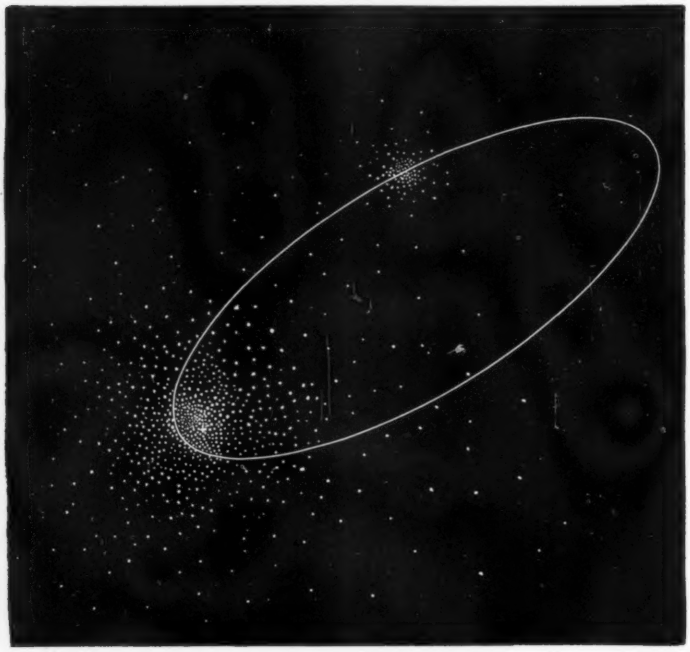


FIG. 32. Cause of variability in uncondensed swarms.

But in this class of condensed bodies we have only really touched one part of the subject, because if that condition holds for bodies which are condensed, it will not have held good for them and for others when they were less condensed than they are now. How, then, can we explain the variability of uncondensed swarms? Fig. 32 shows this.

Here we are dealing with two swarms so sparse that they may be almost considered as nebulæ; and we will suppose that round the denser and larger one a smaller one is moving in the orbit represented on the diagram. You will see that for a considerable part of the orbit the smaller swarm can perform its movement along the orbit without any chance of running up against any of the constituents of the greater swarm; but when that little swarm has got to go round what is called the periastron, *i.e.* the region nearest the centre of gravity, which is occupied by the densest portion of the primary swarm, it is impossible that it can get through without a considerable number of collisions between its own constituents and the constituents of the majority (I am not talking politics). What will happen? You will get light and heat produced, forming a variable star, which will give the greatest amount of light when those two swarms are closest together, and the least amount of light when they are furthest apart.

You can imagine also, that, instead of dealing with a highly elliptic orbit such as imagined in Fig. 32, we may have one in which the main mass is very much nearer the centre of the orbit of the smallest swarm, that orbit being much more circular than in the former case. There you will get a chance of a greater number of collisions in one part of the orbit than in another; but there will not be anything like so great a difference between the number of collisions at the two ends of the major axis of the orbit as there would have been in the first case supposed. In that way, therefore, we can explain the variability of these uncondensed swarms, and not only the variability, but a very considerable difference in the time of the cycle occupied by the changes and in the intensity of the greatest

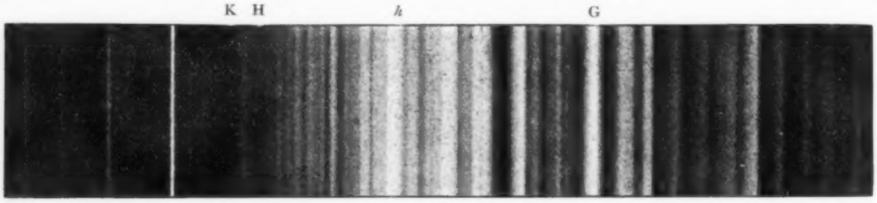


FIG 33.—Spectrum of o Ceti (Pickering).

light produced. So much is that to be anticipated, that I predicted in 1888 that when we got any indications of stars the spectra of which showed that they were really sparse swarms, such as that depicted on the diagram, at the maximum of their luminosity we should get bright lines, and in all probability bright lines of hydrogen, visible in their spectra. It so happened that shortly after this prediction was made—and when a man of science predicts he does it chiefly not for the sake of influencing others, but to point out where the path of truth really lies—I, in common with many other students in this country, received from Prof. Pickering a photograph of the spectrum of that most wonderful of all variable stars, commonly called Mira, or the marvellous star (Fig. 33). We knew before we received the photograph what its spectrum would in all probability be, but the interesting point was to see whether or not there were any bright lines in it. You see there is an obvious bright line at that part of the spectrum which represents the wave-length of one of the hydrogen lines; there is another where the wave-length of another hydrogen line is represented, and there is another very obvious bright line in another part of the spectrum. So that this photograph entirely justifies the prediction that had been made with regard to this class of stars. And so well is that now recognised that, quite independent of the meteoritic hypothesis, one of the most characteristic features of this class of stars is acknowledged to be the appearance at the top of the light curve—at the moment of the greatest giving out of light—the bright lines of hydrogen and possibly of other substances in the spectrum. Forty old variables of this class show bright lines, and twenty new variables have been detected by the appearance of bright lines, *i.e.* bright lines being seen in them suggested that they were variable, and a further inquiry into the old records showed that undoubtedly their light had varied.

J. NORMAN LOCKYER.

(*To be continued.*)

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects has been held this year in Paris, and has proved one of the most successful gatherings of the kind it has ever been our good fortune to attend. It had become known amongst members for some time past that a very strong Reception Committee had been formed, consisting of many French gentlemen, eminent both in the scientific and naval world. A large part of the week devoted to the meeting was given up to purely pleasure excursions and entertainments. Of these it is not within our province to speak, but it would be ungracious on the part of any English journal, dealing with the meeting in any way, not to say a word in recognition of the generous hospitality so lavishly displayed by all those connected with the organisation of the programme in France.

There were three sittings for the reading and discussion of papers; Lord Brassey, the President of the Institution, taking the chair on each occasion. Members assembled for the first time in the new amphitheatre of the Sorbonne, which had been kindly placed at the disposal of the Executive by the Rector of the University of Paris, M. Octave Gréard. Vice-Admiral Charles Duperré, President of the Reception Committee, welcomed the members, and Lord Brassey responded in a brief address.

The following is a list of the papers set down for reading and discussion on the programme.

"The Amplitude of Rolling on a Non-Synchronous Wave," by Émile Bertin, Directeur des Constructions Navales, and Directeur de l'École d'Application Maritime.

"On Wood and Copper Sheathing for Steel Ships," by Sir William White, Director of Naval Construction, and Assistant Controller of the Navy.

"The M.G. Metre," by Archibald Denny.

"On the utility of making the calculation of the total external volume of ships, and of drawing out the complete scale of solidity, from the triple point of view of tonnage laws, stability and load-line," by V. Daymard, Engineer in Chief of the Compagnie Générale Transatlantique.

"On Light Scantling Steamers," by B. Martell, Chief Surveyor Lloyd's Registry of Shipping.

"On Coupling Boilers of Different Systems," by Pierre Sigaudy, Engineer in Chief of the Forges et Chantiers de la Méditerranée.

"On the Cost of Warships," by Francis Elgar.

"On some necessary conditions for resisting intense firing in water tube boilers," by Augustin Normand.

"On the Niclausse Boiler," by Mark Robinson.

M. Bertin's paper, which was the first to be read, treated a highly technical subject from a strictly mathematical point of view. The author pointed out that perfect synchronism between the period of rolling and of the wave is practically a purely theoretical case. He referred to the latest calculations made which bear upon a large number of particular cases, and also to the principle of the graphic method, which has been previously described, and which is a simple extension of the method employed to determine the amplitude of rolling on a synchronous swell. The subject is one of extreme interest, but we fear we must refer those of our readers who are not acquainted with it to the published paper in the volume of the "Transactions" of the Institution. It would be impossible to give an abstract of M. Bertin's mathematics, or, indeed, to make the matter clear without the diagrams which accompanied the paper. One result, however, which may be quoted, is that M. Bertin confirms the facts brought out by Sir William White as to the great increase of efficiency of bilge-keels in large as compared with small ships. This, as our readers are aware, came somewhat as a surprise to those engaged in these matters. M. Bertin states: "We find, therefore, in bilge-keels a more powerful method of checking heavy rolling than has been foreseen. In a different condition of things, free liquid provides a more rapid means of extinguishing small rolls than could have been foreseen from any calculations founded on the known properties of liquids." M. Bertin states that the question upon which he treats is one that cannot be solved by calculation; accurate observations made at sea are the necessary complement of all the theoretical researches and experimental study made in port.

Sir William White opened the discussion on this paper. It will be remembered that at the spring meeting of the Institution the Director of Naval Construction was unable to be present, owing to a very severe illness. In spite of this, a paper which he had written on the subject now under consideration was read in his absence. His reappearance at the meetings was the occasion of a very general outburst of enthusiasm on the part of the members present, for no one is more popular, and indeed few have done more for the Institution, than Sir William White. Sir William pointed out that for mathematical purposes it was necessary to make assumptions which could be corrected by and applied to practical work. He paid a handsome compliment to the author by coupling his name with that of the late Mr. Froude.

The next paper read was Sir William White's own contribution on sheathed ships. This, as the author pointed out, was a direct contrast to the paper last read, being of a simply practical nature. As is well known, the purpose for which steel vessels of war are sheathed with wood, is in order that they may be coppered, and their bottoms may thus be preserved from fouling. It is needless to say that the wooden planking is applied as a means of preventing galvanic action between the copper and steel. In order to effect this, it is necessary that the planking should be water-tight, for sea water, in contact both with the copper and the steel skin, would set up galvanic action. It may be stated, however, in passing, that if the sea water is not in circulation, the galvanic action will not be intense or continuous, which is a fact that might be anticipated. In order to make the planking water-tight, it was originally thought necessary that a double skin should be used, and very elaborate precautions were taken in regard to fastenings. Sir William White, then Mr. White, came to the conclusion that the double planking was unnecessary, and that with proper care a single skin could be made to answer the purpose required. In this he was opposed by a large number of eminent authorities, but having the courage of his convictions, he introduced the new system into Her Majesty's Navy. The result has justified his anticipations, for after several years' experience, the hulls of ships thus sheathed have not been found to suffer.

Mr. Archibald Denny's paper described a small instrument he has invented by which the metacentric height of a vessel can be ascertained. It is intended for the use of captains of ships, so that they may ascertain the stability of their vessels under various conditions of load and trim. The instrument is simply a spirit-level pivoted at one end and adjusted at the other, by means of a micrometer screw. This combined with a diagram gives the value M.G. The method of using the instru-

ment is given in detail in the paper, and is made clear by means of diagrams.

M. Daymard's paper was of a commercial rather than a scientific interest. We all recognise that our tonnage laws are anomalous. Unfortunately they have become so interwoven with our commercial system, that it would require nothing less than a revolution to reduce them to a common-sense standard. M. Daymard commands our admiration by his courageous attempt, but as was shown during the discussion, the new laws he proposes, however unexceptionable from a scientific standpoint, would introduce undesirable features. As indicated by the title, he proposes to take the whole external volume of a ship in estimating her tonnage and load-line as well as stability. This seems reasonable, but as an illustration of the undesirability of such a law, it may be pointed out that the tendency of the ship designer working for commercial ends, as all designers of mercantile vessels must do, would be to stint engine accommodation to the manifest danger and discomfort of the engineering staff. The subject, is, however, one which we need not pursue.

Mr. Martell's contribution was one full of information and instruction to the designer of light draught vessels. Its value consisted chiefly in the thirteen plates of illustration containing details of construction of a large number of vessels designed for shallow water navigation. The descriptions which accompanied the illustrations were also of great practical information.

M. Sigaudy's paper, on coupling boilers of different systems, was a brief but instructive contribution. The introduction of the water-tube boiler, which may be said now to be complete in the case of small and exceedingly fast war vessels, appears likely to make headway even in craft not of this special description. The water-tube boiler is, however, something new, and the average engineer, engaged in practical work, always shies at novelties. That is but natural, and it is the result of common sense that caution should be observed when risks have to be run. By the system advocated by M. Sigaudy, the risk is reduced to the smallest dimensions. In a tug-boat built by his Company, an ordinary return tube marine boiler is combined with two water-tube boilers. The engineers of the vessel have therefore a steam generator at their disposal, which they thoroughly understand, and which is sufficient to supply steam to drive the boat at moderate speed. Should the water-tube boilers fail, therefore, they would not be left helpless. One advantage of the water-tube boilers is that steam can be raised very quickly, and this is a very desirable feature in a tug which has at times to be used in cases of emergency. The time occupied upon two trials in raising steam was respectively 22 and 23 minutes. The consumption of fuel was 1·78 lbs. per horse-power per hour, which, it need hardly be said, is a very satisfactory result. No trouble has been found, since the tug has been used, to arise from the combination of the two systems of boilers. In the discussion which followed the reading of this paper, Mr. Yarrow stated that a similar system has been adopted by the Dutch Government in some cruisers they are having built. These vessels are naturally of much larger size than the tug-boat described by M. Sigaudy, and their trials will be looked forward to with considerable interest by the naval world.

Dr. Elgar's paper, on the cost of war-ships, constituted a new departure in the annals of the Institution. It has generally been considered, if not expressly stated, that financial questions are tabooed by the Institution. In the case of Government vessels, doubtless more latitude should be allowed, but in any event it is a difficult thing to exclude money considerations from discussions on subjects which have a commercial basis. After all, ships are built to earn money, and even the designer of war-ships has to keep the question of cost incessantly before him. It would be useless, for instance, suggesting a new form of marine engine, however perfect from a scientific point of view or economical in its working, if its first cost were to be prohibitive. In the discussion which followed the reading of the paper, views similar to these were expressed by prominent members of the Institution, and it is probable that more latitude will be given for the future in this respect. For our own part, it will be impossible to abstract, in anything like reasonable space, the vast quantities of figures given by the author of the paper. His analysis of the subject was very complete, and it may be stated, briefly, led to the happy conclusion that dockyard-built war vessels are costing less than they did of old, relatively to the work put into them. It may be stated, although Dr. Elgar failed to point the fact out in his paper, that this happy state of affairs is largely due to the good work he himself did when Director of Dockyards.

The last two papers of the meeting were on the subject of the hour, water-tube boilers. M. Normand, the well-known builder of torpedo boats at Havre, and one of the most scientific and best informed marine engineers of the day, gave a very valuable analysis of the points which should be observed in designing a water-tube boiler. Naturally, circulation occupied his chief attention, and it may be said briefly that if sufficient activity of circulation of water and steam in the boiler can be maintained, that boiler is likely to be an efficient steam generator. How to obtain such circulation is a complex and disputed question, and here we find our own great authority on the subject, Mr. Thornycroft, at issue with the author of the paper. Mr. Thornycroft, as is well known, is a strong advocate of above water discharge into the steam drum. M. Normand, on the other hand, upholds "drowned" tubes. The subject is a large one, far too large for discussion in a report of this nature. To us it appears that M. Normand is not warranted in all the assumptions upon which he bases his conclusion, and further it may be said that Mr. Thornycroft has experimental data on his side in maintaining that the circulation of water is more active with above water discharge than with drowned tubes. Whether with the latter the circulation is sufficiently active for all practical purposes is of course another matter, the bearing of which it remains for practical experience to prove. For, like the problem M. Bertin attacked in his paper, it is not solvable by theoretical analysis.

Mr. Mark Robinson, in his paper, described a very promising form of water-tube boiler which has been introduced in France by M. Niclausse, the inventor. Without illustrations it would be utterly impossible to make the design clear; but it may be said that the principle followed is that of the Field tube, in which circulation is promoted by means of a pipe inside and coaxial with the heating tube. Curiously enough, however, the tubes in the Niclausse boiler are horizontal, or approximately horizontal, so that the circulation is maintained in the "header" which is divided by a diaphragm, the difference between the specific gravities of the water, or water and steam, contained on each side of the diaphragm causing the movement of the water. This boiler appears to be one of great promise amongst water-tube boilers in situations where the highest evaporative efficiency is not required. It is, however, in these positions that the ordinary return tube boiler is strongest. Whether it will be supplanted by a water-tube boiler remains to be seen; but should such be the case, the Niclausse boiler has the anpearance of being a formidable competitor.

No account of the Paris meeting would be complete without reference being made to the beautiful series of photographs shown by M. Bertin in illustration of the movements of ships in a sea-wave. These photographs were taken by the method devised by M. Marey, to which reference has already been made in these columns. A dozen or more different views are given of a ship during its passage through a wave, and the whole movement can thus be fixed and analysed. The value of such data to the naval architect is, of course, immense. In connection with these photographs, which were shown on the screen, there were also exhibited some very beautiful projections of photographs in colours. These were shown by M. Charles Comte, one of M. Marey's assistants. The subject is one which has been attracting attention of late, and has been referred to elsewhere in these columns.

METEOROLOGICAL PROBLEMS FOR PHYSICAL LABORATORIES.

IN response to several requests from both teachers and students for suggestions as to problems that can be taken up in physical laboratories, Prof. Cleveland Abbe gives the following list of subjects, in the *American Meteorological Journal* for May. The initialled subjects are due to Prof. C. F. Marvin.

SUBJECTS FOR EXPERIMENTAL INVESTIGATION.

(1) The internal sensitiveness of thermometers, or the length of time required to bring the top of the thermometer column to the proper reading when the external surface of bulb and stem is kept at a constant temperature below, or above, some initial temperature.

(2) The influence of the wind on the pressure within a room, or other closed space, containing a barometer.

(3) The influence of the condition of any surface (as to

chemical nature, cleanness, and dust) upon the deposition of dew and the determination of the dew-point.

(4) The behaviour of the wet-bulb thermometer, when covered with water, in an atmosphere of water vapour and of ice vapour.

(5) The influence of radiant heat on wet bulbs covered with ice or water.

(6) The increase of the reading of the wet-bulb thermometer due to any compression that may result from the formation of the ice film on the muslin covering; its dependence on the muslin rather than on the ice.

(7) The determination of the tension of water vapour and ice vapour at and below freezing.

(8) The rate of diffusion of ice vapour as distinguished from aqueous vapour, and also the rates of evaporation from ice and water at the same temperature.

(9) The condensation of vapour in a region free from solid nuclei, and after the temperature has been reduced to, or below, the point of saturation so that the vapour is in a state of unstable equilibrium.

(10) The change that can be produced in the pressure and temperature of a confined volume of *dust free* "dry saturated" steam or other vapour by the introduction of dust particles having various chemical and physical properties. This is the secret of the action of the "cloud engine" of Montgomery J. Storms.

(11) Invention of improved and practical methods of obtaining the moisture contents of the air—especially at low temperatures. —C. F. M.

(12) Invention of recording thermometers, barometers, and hygrometers adapted by their accuracy, their extreme lightness, and the quickness with which they respond to atmospheric changes, to be carried up by balloons and by kites in investigations into the condition of the higher atmosphere.—C. F. M.

(13) The development and perfecting of the art of constructing and flying kites with a view of rendering this practically applicable in investigations of the condition of the atmosphere at moderate elevations.—C. F. M.

(14) Invention of improved and practical devices for the registration of sunshine and cloudiness, both day and night.—C. F. M.

(15) Invention of devices recording exactly the beginnings and endings, amounts and rates, of precipitation, &c.—C. F. M.

(16) Explanation of the formation of ice-needles in gravelly soil, and determination of the amount of heat and moisture retained at the earth's surface by this formation.

(17) Explanation of the origin of the hollow tubes in the ice-needles and the similar hollow tubes in snow crystals and the analogous holes in hailstones.

(18) The connection between atmospheric conditions and the formation of snow crystals of different shapes and sizes.

(19) The radiating and conducting powers of layers of snow freshly fallen or old and granulated.

(20) The radiation and absorption of heat by dustless, dry air, and also by ordinary atmospheric air containing dust and vapour or ice particles.

(21) Investigation of the formula for computing the velocity and the pressure of the wind from various forms of anemometers, especially the whirling, the pressure, and the suction anemometers.

(22) Invention of the most convenient and cheapest form of nephoscope for determining either direction or velocity, or both these elements of the motion of the clouds.

(23) Investigation of the correction to be made to the record of the ordinary cylindrical rain and snow gauge for the effect of the wind in drifting the rain, and especially the snow.

(24) Study of the temperature of the soil at different depths from the surface-layer down to three feet and under different conditions, as to moisture-content, sunshine, and wind.

(25) Invention of better methods of determining at any moment the temperature and moisture at any depth in the soil.

(26) Determination of the quantity of water evaporated from natural surfaces, especially ocean water, ice or snow, fresh water, and forests or cultivated fields, and its relation to humidity, temperature, and wind.

(27) Improvements in the actinometer and a series of determinations of the amounts of heat received at any point, both from the sun directly and from the clouds and the atmosphere by reflection or radiation.

(28) Observations of the polarisation and the intensity of blue sky light and comparison with optical theories.

(29) Instrumental methods for recording some of the various chemical effects directly produced by solar radiation, and which are of special importance in the growth of plants, the decomposition of the soil, and the purification of water.

(30) A series of determinations or, still better, a continuous record of the simultaneous differences of electric potential between the earth's surface, and several points in the free atmosphere, one hundred feet apart, vertically, meridionally, and prime-vertically.

(31) A similar series for several points beneath the earth's surface as to their electro-magnetic condition, and a correlation of the distribution of electric conditions with the electric currents in the air and the earth.

(32) A study of the scintillation of the stars and its relation to atmospheric conditions.

(33) A study of the apparent acoustic opacity of the atmosphere at certain places and times.

(34) An explanation of the sounds attending large aerolites, and an explanation as to what may be learned therefrom regarding the upper atmosphere and in regard to the improvement of fog signals.

(35) A study of the formation of halos, parhelia, and corona, by the action of snow crystals and water-drops on sunlight.

(36) Investigation of the first step in the process of convection, as it occurs in the free atmosphere by which small currents of warm air, rising as slender rolls and whirls, mix with the cooler air, and are broken up within a few feet of the earth's surface; a determination of the limit at which such convection becomes inappreciable.

(37) A study of the larger convection currents, their relation to the horizontal motion, the extent to which they retard and accelerate the motions or increase and decrease the pressures in the upper and lower strata.

THE SENSES OF INSECTS.[1]

OF the five ordinary senses recognised in ourselves and most higher animals, insects have, beyond all doubt, the sense of sight, and there can be as little question that they possess the senses of touch, taste, smell, and hearing. Yet, save perhaps that of touch, none of these senses, as possessed by insects, can be strictly compared with our own, while there is the best of evidence that insects possess other senses which we do not, and that they have sense organs with which we have none to compare. He who tries to comprehend the mechanism of our own senses—the manner in which the subtler sensations are conveyed to the brain—will realise how little we know thereof after all that has been written. It is not to be wondered at, therefore, that authors should differ as to the nature of many of the sense organs of insects, or that there should be little or no absolute knowledge of the manner in which the senses act upon them. The solution of psychical problems may never, indeed, be obtained, so infinitely minute are the ultimate atoms of matter; and those who have given most attention to the subject must echo the sentiment of Lubbock, that the principal impression which the more recent works on the intelligence and senses of animals leave on the mind is that we know very little, indeed, on the subject. We can but empirically observe and experiment and draw conclusions from well attested results.

Sight.—Taking first the sense of sight, much has been written as to the picture which the compound eye of insects produces upon the brain or upon the nerve centres. Most insects which undergo complete metamorphoses possess in their adolescent states simple eyes or ocelli, and sometimes groups of them of varying size and in varying situations. It is difficult, if not impossible, to demonstrate experimentally their efficiency as organs of sight; the probabilities are that they give but the faintest impressions, but otherwise act as do our own. The fact that they are possessed only by larvæ which are exposed more or less fully to the light, while those larvæ which are endophytous, or otherwise hidden from light, generally lack them, is in itself proof that they perform the ordinary functions of sight, however low in degree. In the imago state the great majority of insects have their simple eyes in addition to the compound eyes. In many cases, however, the former are more or less covered with vestiture, which is another evidence that their function is of a low

[1] From an address on "Social Insects," delivered by Prof. C. V. Riley, as President of the Biological Society of Washington. (Reprinted (slightly condensed) from *Insect Life*, vol. vii. No. I.")

order, and lends weight to the view that they are useful chiefly for near vision and in dark places. The compound eyes are prominent and adjustable in proportion as they are of service to the species, as witness those of the common house-fly and of the Libellulidæ or dragon-flies. It is obvious from the structure of these compound eyes that impressions through them must be very different from those received through our own, and, in point of fact, the experimental researches of Hickson, Plateau, Tocke and Lemmermann, Pankrath, Exner, and Viallanes have practically established the fact that while insects are shortsighted and perceive stationary objects imperfectly, yet their compound eyes are better fitted than the vertebrate eye for apprehending objects set in relief or in motion, and are likewise keenly sensitive to colour.

So far as experiments have gone, they show that insects have a keen colour sense, though here again their sensations of colour are different from those produced upon us. Thus, as Lubbock has shown, ants are very sensitive to the ultra-violet rays of the spectrum, which we cannot perceive, though he was led to conclude that to the ant the general aspect of nature is presented in an aspect very different from that in which it appears to us. In reference to bees, the experiments of the same author prove clearly that they have this sense of colour highly developed, as indeed might be expected when we consider the part they have played in the development of flowers. While these experiments seem to show that blue is the bee's favourite colour, this does not accord with Albert Müller's experience in nature, nor with the general experience of apiarians, who, if asked, would very generally agree that bees show a preference for white flowers.

Touch.—The sense of touch is supposed to reside chiefly in the antennæ or feelers, though it requires but the simplest observation to show that with soft-bodied insects the sense resides in any portion of the body, very much as it does in other animals. In short, this is the one sense which, in its manifestations, may be conceded to resemble our own. Yet it is evidently more specialised in the maxillary and labial palpi and the tongue than in the antennæ in most insects.

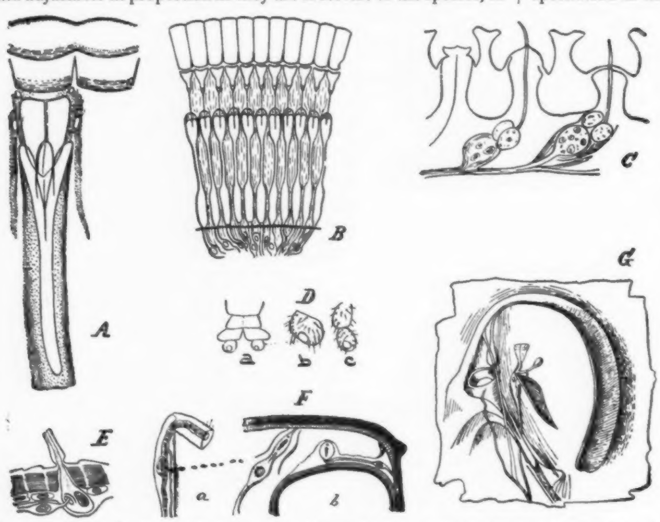


FIG. 1.—Sensory Organs in Insects: A, one element of eye of cockroach (after Grenacher); B, diagrammatic section of compound eye in insect (after Miall and Denny); C, organs of smell in Melolontha (after Kraepelin); D, *a*, *b*, sense organs of abdominal appendages of Chrysopila; *c*, small pit on terminal joint of palpus in Perla (after Packard); E, diagram of sensory ear of insect (after Miall and Denny); F, auditory apparatus of Meconema; *a*, fore tibia of this locust; *b*, diagrammatic section through same (after Graber); G, auditory apparatus of Caloptenus, seen from inner side, showing tympanum, auditory nerve, terminal ganglion, stigma, and opening and closing muscle of same, as well as muscle of tympanum membrane (after Graber).—All very greatly enlarged.

Taste.—Very little can be positively proved as to the sense of taste in insects. Its existence may be confidently predicated from the acute discrimination which most monophagous species exercise in the choice of their food, and its location may be assumed to be the mouth or some of the special trophial organs which have no counterpart among vertebrates. Indeed, certain pits in the epipharynx of many mandibulate insects and in the ligula and the maxillæ of bees and wasps are conceded by the authorities to be gustatory.

Smell.—That insects possess the power of smell is a matter of common observation, and has been experimentally proved. The many experiments of Lubbock upon ants left no doubt in his mind that the sense of smell is highly developed in them. Indeed, it is the acuteness of the sense of smell which attracts many insects so unerringly to given objects, and which has led many persons to believe them sharp-sighted. Moreover, the innumerable glands and special organs for secreting odours furnish the strongest indirect proof of the same fact. Some of these, of which the osmaterium in Papilionid larvæ and the eversible glands in Parorgyia are conspicuous examples, are intended for protection against inimical insects or other animals; while others, possessed by one only of the sexes, are obviously intended to please or attract. A notable development of this kind is seen in the large gland on the hind legs of the males of some species of Hepialus, the gland being a modification of the tibia, and sometimes involving the abortion of the tarsus, as in the European *H. hectus* (L.) and our own *H. behrensi* (Stretch.) The possession of odoriferous glands, in other words, implies the pos-

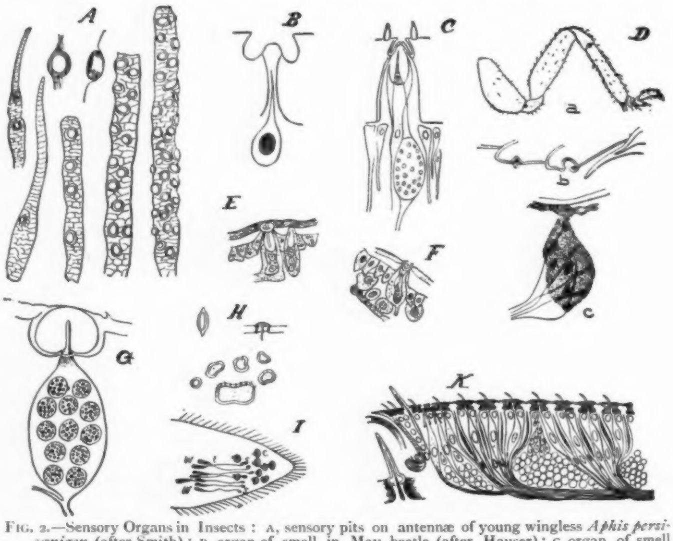


FIG. 2.—Sensory Organs in Insects: A, sensory pits on antennæ of young wingless *Aphis persicæniger* (after Smith); B, organ of smell in May beetle (after Hauser); C, organ of smell in Vespa (after Hauser); D, sensory organs of *Termes flavipes*; *a*, tibial auditory organ; *c*, enlargement of same; *b*, sensory pits of tarsus (after Stokes); E, organ of taste in maxillæ of *Vespa vulgaris* (after Will); F, organ of taste in labium of same insect (after Will); G, organ of smell in Caloptenus (after Hauser); H, sensory pilose depressions on tibia of Termes (after Stokes); I, terminal portion of antennæ of *Myrmica ruginodis*; *c*, cork-shaped organs; *s*, outer sac; *t*, tube; *w*, posterior chamber (after Lubbock); K, longitudinal section through portion of flagellum of antennæ of worker bee, showing sensory hairs and supposed olfactory organs (after Cheshire). All very greatly enlarged.

session of olfactory organs. Yet there is among insects no one specialised olfactory organ as among vertebrates; for while there is conclusive proof that this sense rests in the antennæ with many insects, especially among Lepidoptera, there is good evidence that in some Hymenoptera it is localised in an ampulla at the base of the tongue, while Graber gives reasons for believing that in certain Orthoptera (Blattidæ) it is located in the anal cerci and the palpi.

Hearing.—In regard to the sense of hearing, the most casual experimentation will show (and general experience confirms it) that most insects, while keenly alive to the slightest movements or vibrations, are for the most part deaf to the sounds which affect us. That they have a sense of sound is equally certain. but its range is very different from ours. A sensitive flame, arranged for Lubbock by the late Prof. Tyndall, gave no response from ants, and a sensitive microphone, arranged for him by Prof. Bell, gave record of no other sound than the patter of feet in walking. But the most sensitive tests we can experimentally apply may be, and doubtless are, too gross to adjust themselves to the finer sensibilities of such minute, active, and nervous creatures. There can be no question that insects not only produce sounds, but receive the impression of sounds entirely beyond our own range of perception, or, as Lubbock puts it, that "we can no more form an idea of than we should have been able to conceive red or green if the human race had been blind. The human ear is sensitive to vibrations reaching at the outside to 38,000 in a second. The sensation of red is produced when 470 millions of millions of vibrations enter the eye in a similar time; but between these two numbers vibrations produce on us only the sensation of heat. We have no especial organ of sense adapted to them." It is quite certain that ants do make sounds, and the sound-producing organs on some of the abdominal joints have been carefully described. The fact that so many insects have the power of producing sounds that are even audible to us, is the best evidence that they possess auditory organs. These are, however, never vocal, but are situated upon various parts of the body, or upon different members thereof.

Special Sense and Sense Organs.—While from what has preceded it is somewhat difficult to compare the more obvious senses possessed by insects with our own, except perhaps in the sense of touch, it is, I repeat, just as obvious to the careful student of insect life that they possess special senses which it is difficult for us to comprehend. The sense of direction, for instance, is very marked in the social Hymenoptera which we have been considering, and in this respect insects remind us of many of the lower vertebrates which have this sense much more strongly developed than we have. Indeed, they manifest more especially what has been referred to in man as a sixth sense, viz. a certain intuition which is essentially psychical, and which undoubtedly serves and acts to the advantage of the species as fully, perhaps, as any of the other senses. Lubbock demonstrated that an ant will recognise one of its own colony from among the individuals of another colony of the same species; and when we consider that the members of a colony number at times, not thousands, but hundreds of thousands, this remarkable power will be fully appreciated.

The neuter Termites are blind, and can have no sense of light in their internal or subterranean burrowings; yet they will undermine buildings, and pulverise various parts of elaborate furniture without once gnawing through to the surface; and those species which use clay, will fill up their burrowings to strengthen the supports of structures which might otherwise fall and injure the insects or betray their work. The bat in a lighted room, though blinded as to sight, will fly in all directions with such swiftness and infallible certainty of avoiding concussion or contact, that its feeling at a distance is practically incomprehensible to us.

Telepathy.—But however difficult it may be to define this intuitive sense which, while apparently combining some of the other senses, has many attributes peculiar to itself, and however difficult it may be for us to analyse the remarkable sense of direction, there can be no doubt that many insects possess the power of communicating at a distance, of which we can form some conception by what is known as telepathy in man. This power would seem to depend neither upon scent nor upon hearing in the ordinary understanding of these senses, but rather on certain subtle vibrations as difficult for us to comprehend as is the exact nature of electricity. The fact that men can telegraphically transmit sound almost instantaneously around the globe, and that his very speech may be telephonically transmitted, as quickly as uttered, for thousands of miles, may suggest something of this subtle power, even though it furnish no explanation thereof.

The power of sembling amongst certain moths, for instance, especially those of the family Bombycidæ, is well known to entomologists, and many remarkable instances are recorded. I am tempted to put on record for the first time an individual experience which very well illustrates this power, as on a number of occasions when I have narrated it most persons not familiar with the general facts have deemed it remarkable. In 1863 I obtained from the then Commissioner of Agriculture, Colonel Capron, eggs of *Samia cynthia*, the Ailanthus silkworm of Japan, which had been recently introduced by him. I was living in Chicago at the time, and in my garden there grew two Ailanthus trees, which were the cause of my sending for the aforesaid eggs. I had every reason to believe that there were no other eggs of this species received in any part of the country within hundreds of miles around. It seemed a good opportunity to test the power of this sembling, and after rearing a number of larvæ I carefully watched for the appearance of the first moths from the cocoons. I kept the first moths separate, and confining a virgin female in an improvised wicker cage out of doors on one of the Ailanthus trees. On the same evening I took a male to another part of the city, and let him loose, having previously tied a silk thread around the base of the abdomen to insure identification. The distance between the captive female and the released male was at least a mile and a half, and yet the next morning these two individuals were together.

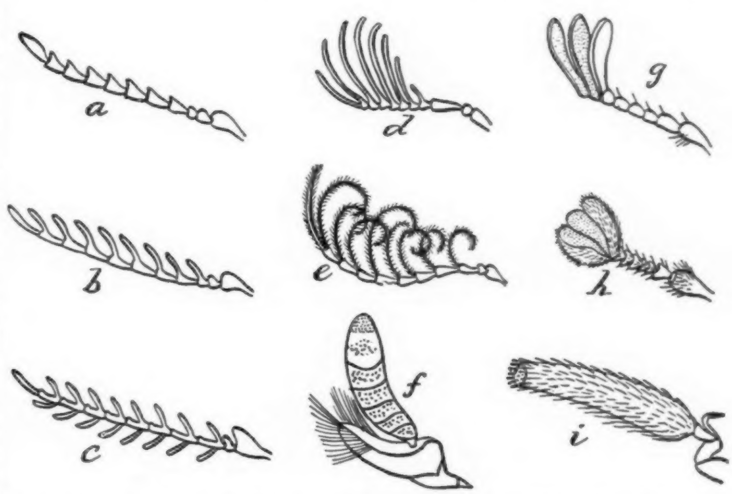


FIG. 3.—Some Antennæ of Coleoptera: *a*, Ludius; *b*, Corymbites; *c*, Prinocyphon; *d*, Acneus; *e*, Dendroides; *f*, Dineutes; *g*, Lachnosterna; *h*, Bolbocerus; *i*, Adranes (after Le Conte and Horn).—All greatly enlarged.

Now, in the moths of this family the male antennæ are elaborately pectinate, the pectinations broad and each branch minutely hairy (see Fig. 5, *a*.) These feelers vibrate incessantly, while in the female, in which the feelers are less complex, there is a similar movement connected with an intense vibration of the whole body and of the wings. There is, therefore, every reason to believe that the sense is in some way a vibratory sense, as, indeed, at base is true of all senses, and no one can study the wonderfully diversified structure of the antennæ in insects,

especially in males, as very well exemplified in some of the commoner gnats (see Fig. 5, *d*, *e*), without feeling that they have been developed in obedience to, and as a result of, some such subtle and intuitive power as this of telepathy. Every minute ramification of the wonderfully delicate feelers of the male mosquito, in all probability, pulsates in response to the piping sounds which the female is known to produce, and doubtless through considerable distance.

There is every justification for believing that all the subtle cosmic forces involved in the generation and development of the

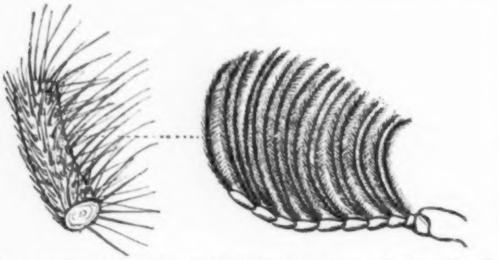


FIG. 4.—Antenna of male Phengodes with portion of ray.—Greatly enlarged (original).

highest are equally involved in the production and building up of the lowest of organisms, and that the complexing and compounding and specialisation of parts have gone on in every possible and conceivable direction, according to the species. The highly developed and delicate antennæ in the male Chironomus, for instance, may be likened to an external brain, its ramifying fibres corresponding to the highly complicated pro-

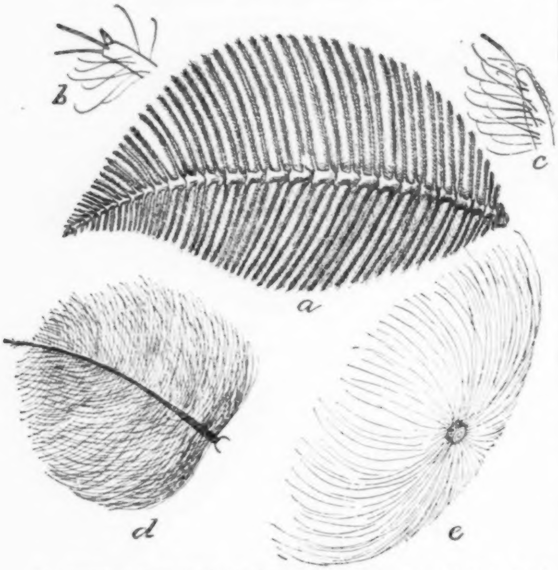


FIG. 5.—Some Antennæ of Insects: *a*, Telea polyphemus, male, × 3; *b* and *c*, tip of the rays of same—still more enlarged; *d*, Chironomus × 6; *e*, section of same—still more enlarged (original).

cesses that ramify from the nerve cells in the internal brains of higher animals, and responding in a somewhat similar way to external impressions. While having no sort of sympathy with the foolish notions that the spiritualists proclaim, to edify or terrify the gullible and unscientific, I am just as much out of sympathy with that class of materialists who refuse to recognise that there may be and are subtle psychical phenomena beyond the reach of present experimental methods. The one class too readily assumes supernatural power to explain abnormal phenomena; the other denies the abnormal, because it, likewise, is past our limited understanding.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness Scholarship in Geology has been awarded to Arthur William Rogers, of Christ's College.

Mr. J. S. Gardiner, of Caius College, has been chosen to occupy the University's table at the Naples Zoological Station for six months from October 1.

The Newall Observer reports that the fine spectroscope designed for use with the Newall Telescope is now ready, and that the preliminary trials of it have been satisfactory. The mounting has been made by the Cambridge Scientific Instrument Company, and the optical parts by Mr. Brashear, of Alleghany.

Mr. F. Darwin, Mr. W. G. P. Ellis, Prof. Liveing, Mr. T. B. Wood, Prof. M. Foster, Mr. A. Eichholz, Mr. A. E. Shipley, Mr. C. Warburton, Prof. Hughes, Mr. P. Lake, Mr. O. P. Fisher, Mr. J. Owen, Mr. R. Menzies, and Mr. C. B. Fisher, have been appointed Examiners in the Science and Art of Agriculture for the University Diploma. The examination will be held in July.

Sir David L. Salomons, Bart., has founded, in connection with Caius College, a Scholarship in Engineering. The first award will be made in October. The value of the Scholarship is £40 a year for three years. The Salomons Scholar must become a candidate for the Mechanical Sciences Tripos. Applications for further information should be made to the Tutors of Caius College.

THE Conference on Technical Education held at the Society of Arts last Thursday, resulted in the adoption of the following resolution:—"That in the opinion of this meeting it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by technical instruction committees but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that with the object of giving effect to the same this conference recommends that a representative committee be appointed to draw up a report and prepare recommendations on the whole subject."

SCIENTIFIC SERIALS.

American Journal of Science, June.—The preparation of perchloric acid and its application to the determination of potassium, by D. Albert Kreider. The difficulty attending the removal of the potassium in the ordinary preparation of this acid from potassium chlorate may be overcome by using the sodium salt instead. The insolubility of chloride of sodium in strong hydrochloric acid, with the aid of the acid-proof Gooch crucible, affords a means for the liberation of the perchloric acid and the removal of the greater part of the sodium in one operation. Sodium chlorate is heated until it gives off oxygen. When all the possible oxygen has been given off, and only the chloride and the perchlorate remain, the residue is treated with strong hydrochloric acid and filtered The perchloric acid is thus liberated, and the sodium precipitated as chloride. The liquid is decanted, and undergoes the same operation again. The solution, containing hydrochloric and perchloric acids and a small amount of sodium chloride, is evaporated till the former acid is driven off and the heavy white fumes of the perchloric acid appear. It is then ready for potassium determinations, with which the small residue of sodium does not interfere. The filtering is done by means of a Gooch crucible, and the operation requires less time and attention than the old process, and is much less dangerous.—Mode of growth and development of the grapholitic genus *Diplograptus*, by R. Ruedemann By the possession of a pneumatocyst and the arrangement of the reproductive organs at the bases of the stipes, the colonial stocks of *Diplograptus* have a general similarity to those of certain *Siphonophoræ*, while the chitinous structure of the hydrothecæ and gonangia can only be referred to the Sertularians. It thus becomes evident that the genus *Diplograptus*, like so many palæozoic fossils, has the combined properties of different groups, thus giving valuable hints in regard to the common ancestors of those groups.—On the elevation along the Rocky Mountain range in British America since the close of the Cretaceous period, by Dr. G. M. Dawson. In the mountains, the cretaceous rocks have been involved in all the flexure, faulting, and overthrust suffered by the Palæozoic; and both in the mountains and foothills these rocks are found at all angles up to vertical, and even overturned.

It is thus difficult to know the amount of elevation of these rocks, but about latitude 50° the base of the cretaceous must in several places have considerably exceeded 10,000 feet in altitude.

Symons's Monthly Meteorological Magazine, June.—The principal article deals with rainfall in China, with remarks by the editor, based on observations made from 1886-92, and published in various places by Dr. Doberck, of Hong Kong. The mean annual rainfall is small in the north, and increases greatly towards the south. In the Gulf of Pe-chi-li the fall is 20 inches, but reaches double that amount in the Delta of the Yang-Tse-Kiang, 58 inches at Hankow, and 68 inches at Ningpo. In Formosa it ranges from 60 to 90 inches, but at Keelung, in the north-east, it reaches 148 inches. The seasonal rainfall is shown in tables divided into six districts. Notwithstanding the proximity of most of the stations to the sea, the distribution is, generally speaking, of that type which prevails over the greater part of Asia.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 24.—"Micro-Metallography of Iron." Part I. By Thomas Andrews, F.R.S.

In the course of a research with high microscopical powers (including 300, 500, 800, 1200, and upwards to 2000 diameters) on the micro-crystalline structure of large masses of wrought iron, the author observed the following novel metallurgical facts:—

When large masses, several tons in weight, of practically pure wrought iron were allowed to slowly cool from a white heat, a secondary or subcrystallisation of the metallic iron occurred. The normal primary crystals of the iron, or those which have hitherto been regarded as constituting the ultimate structure of the metal, were found to enclose a subcrystalline formation consisting of very minute, and much smaller, crystals of pure iron also belonging to the regular order of crystallisation. These crystals sometimes manifested the hexagonal form, the predominant angle being about 120°, and often they assumed the form of simple cubes. The secondary crystals were contained within the area of the larger primary crystals.

Typical illustrations of this duplex crystallisation found in two large iron forgings are given in Figs. 1 and 2, and the relative dimensions of a number of individual crystals are given in the paper.

The results of twenty measurements of the primary crystals and twenty measurements of the secondary crystals taken on each forging are given on these tables.

The markings of the intercrystalline spaces or junctions of the secondary crystals were very clearly defined, but they were exceedingly minute. The general form, contour, and relative size of the primary and secondary crystals, as seen in section, will be noticed on reference to the accurate tracings, Figs. 1 and 2. The linear dimensions of the primary crystals would average about 0·01 inch, the linear dimensions of the secondary crystals averaging about 0·001 inch.

Judging roughly from the indications of the average micro-measurements, there would appear to be approximately 1,000,000,000 of the secondary crystals in a cubic inch of the metallic iron.

In the case of both the primary and secondary crystals the predominant well-defined angles of the facets of the crystals hovered more or less about the angle of 120°. The majority of the angle readings, made with the goniometer attached to the microscope, indicating generally a hexagonal structure on form of crystallisation. There were, however, also perfect cubical crystals observed.

The observations were made with a Ross first-class microscope. The micro-measurements afford an indication of the comparative size of the primary and secondary crystals. These measurements were carefully taken by a Jackson micrometer, and in some cases by a Ramsden screw micrometer, both accurately calibrated with a standard stage micrometer. The wrought iron forgings on which the observations were made were constituted of practically pure hammered wrought iron, the dimensions of the mass being about 10 feet long and about 12 inches square. The great length of time required for such large masses of iron to cool from a white heat appeared to facilitate the production of the crystals of the secondary formation.

The *rationale* of this duplex crystallisation has apparently been as follows:—The mass of metallic iron on cooling having reached the crystallising point at about 740° C., the periphery or skeletons of the larger or primary crystals were then formed. As the period of cooling was, however, very slow, the semi-fluid or viscous metal in the interior of these primary crystals was, on finally consolidating, apparently further broken up or subdivided

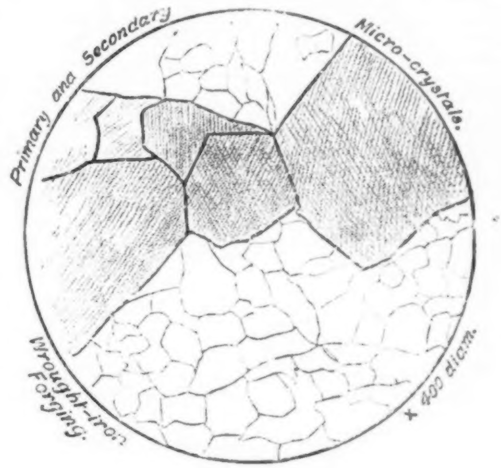


FIG. 1.

into a considerable number of smaller crystals, enclosed within the boundary or periphery of the primary crystals.

In the course of further experiments on the cooling of large masses of wrought iron, the author has also found, by the use of high power objectives, that the secondary crystals sometimes enclosed a still more minute form of crystals of pure iron, of the cubical form, which may hence be regarded as constituting a tertiary system of crystallisation in pure metallic iron. These

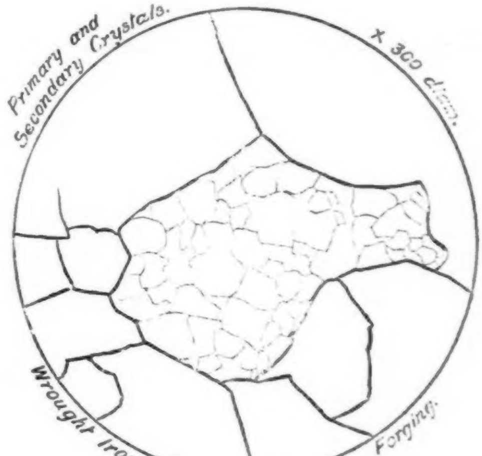


FIG. 2.

experiments therefore indicate that large masses of heated wrought iron, on cooling from above the temperature of the crystallisation of metallic iron, viz. 740° C., are capable of crystallising in three distinct modifications which may tentatively be called the primary, secondary, and tertiary system of crystallisation in iron, these various crystalline modifications being all, however, connected with the regular system of crystallisation.

The crystals of this secondary formation are not often distinctly discernible in smaller masses of metallic iron, such as rolled rods, plates, or sheets, as these in the course of manufacture rapidly cool, and are frequently manipulated during the finishing processes at temperatures below the crystallising point of wrought iron (740° C.).

The microscopical examinations were made on carefully prepared and polished samples, etched in nitric acid (1 part HNO_3, sp. gr. 1·20, and 49 parts water), and by the use of high microscopical powers ($\frac{1}{4}$-inch to $\frac{1}{18}$-inch, and other ojectives). The drawings were accurately made with the camera lucida. In each observation the etching was prolonged, under constant observation with lenses, a suitable time to develop the accurate structure of the metal.

June 13.—"On the New Gas obtained from Uraninite." Fourth Note. By J. Norman Lockyer, C.B., F.R.S.

Continued experiments on the gases obtained by heating the minerals broggerite and euxenite *in vacuo* have revealed the presence in the spectrum of an important line in the infra-red. By comparisons wlth the solar spectrum in the first order grating spectrum, the wave-length of the line has been approximately determined as 7065. There can be little doubt, from the observations which have been made, that this new line is coincident with a chromospheric line which occurs in Young's list, having a frequency of 100, and of which the wave-length on Rowland's scale is stated to be 7065·5.

It follows therefore that, besides the hydrogen lines, all three chromospheric lines in Young's list which have a frequency of 100 have now been recorded in the spectra of the new gas or gases obtained from minerals by the distillation method.

These are as follows:—

7065·5
5875·98
4471·8

The wave-lengths of the lines are in Rowland's scale, as given in Scheiner's "Astronomical Spectroscopy."[1] In a partial revision of his chromospheric list, Prof. Young gives the *corona* line 5316·79 as also having a frequency of 100 in the chromosphere, but, up to the present, this line has not been among those obtained in the laboratory.

"On the New Gas obtained from Uraninite." Fifth Note. By J. Norman Lockyer, C.B., F.R.S.

In a former communication I pointed out the spectroscopic evidence, furnished by the isolation of lines in certain minerals, which indicates that the complete spectrum obtained when bröggerite is submitted to the distillation method is produced by a mixture of gases.

In order to test this view, I have recently made some observations, based on the following considerations:—

(1) In a simple gas like hydrogen, when the tension of the electric current given by an induction coil is increased, by inserting first a jar, and then an air-break into the circuit, the effect is to increase the brilliancy and breadth of all the lines, the brilliancy and breadth being greatest when the longest air-break is used.

[1] Frost's translation, p. 184.

(2) Contrariwise, when we are dealing with a known compound gas; at the lowest tension we may get the complete spectrum of the compound without any trace of its constituents, and we may then, by increasing the tension, gradually bring in the lines of the constituents until, when complete dissociation is finally reached, the spectrum of the compound itself disappears.

Working on these lines, the spectrum of the spark at atmospheric pressure, passing through the gas, or gases, distilled from bröggerite, has been studied with reference to the special lines C (hydrogen), D_3, 667, and 447.

The first result is that all the lines do not vary equally, as they should do if we were dealing with a simple gas.

The second result is that at the lowest tension 667 is relatively more brilliant than the other lines; on increasing the tension, C and D_3 considerably increase their brilliancy, 667 relatively and absolutely becoming more feeble; while 447, seen easily as a narrow line at low tension, is almost broadened out into invisibility as the tension is increased in some of the tubes, or is greatly brightened as well as broadened in others (Fig. 1).

FIG. 1.—Diagram showing changes in intensities of lines brought about by varying the tension of the spark. (1) Without air-break. (2) With air-break.

The above observations were made with a battery of five Grove cells; the reduction of cells from 5 to 2 made no difference in the phenomena except in reducing their brilliancy.

Reasoning from the above observations, it seems evident that the effect of the higher tension is to break up a compound, or compounds, of which C, D_3, and 447 represent constituent elements; while, at the same time, it would appear that 667 represents a line of some compound which is simultaneously dissociated.

The unequal behaviour of the lines has been further noted in another experiment, in which the products of distillation of bröggerite were observed in a vacuum tube and photographed at various stages. After the first heating, D_3 and 4471 were seen bright, before any lines other than those of carbon and hydrogen made their appearance. With continued heating, 667, 5016, and 492 also appeared, although there was no notable increase of brightness in the yellow line; still further heating introduced additional lines 5048 and 6347.

These changes are represented graphically in the following diagram (Fig. 2).

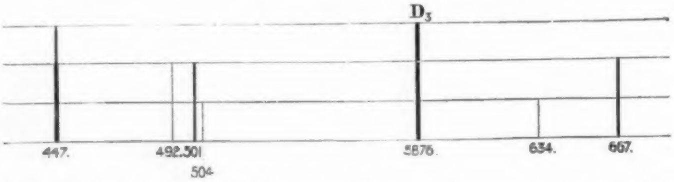


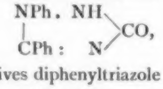
FIG. 2. Diagram showing order in which lines appear in spectrum of vacuum tube when bröggerite is heated.

It was recorded further that the yellow line was at times dimmed, while the other lines were brightened.

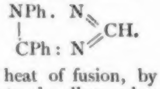
"On the Origin of the Triradiate Spicules of *Leucosolenia*." By E. A. Minchin.

Chemical Society, June 6.—Mr. A. Vernon Harcourt, President, in the chair.—The following papers were read:—The molecular refractions of dissolved salts and acids, by J. H. Gladstone and W. Hibbert. The authors show that in many cases when a pure substance dissolves in water, an alteration of its specific refractive energy occurs.—A comparison of some properties of acetic acid and its chloro- and bromo-derivatives, by S. U. Pickering. A number of thermal and other physical properties of acetic acid, and its monochloro- and monobromoderivatives have been quantitatively examined and compared; four distinct crystalline modifications of monochloracetic acid

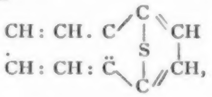
have been prepared.—ββ-Dinaphthyl and its quinones, by F. D. Chattaway. Two quinones are obtained by oxidising ββ-dinaphthyl under different conditions; from their chemical behaviour these seem to be β-naphthyl naphthoquinone, $C_{10}H_5.O.C_{10}H_7.O$ (1 : 2 : 4) and ββ-di-α-naphthoquinone, $C_{10}H_5O_2.C_{10}H_5O_2$ (1 : 2 : 4 : 1 : 2 : 4).—Action of benzaldehyde on phenylsemicarbazide, by G. Young. The interaction of benzaldehyde and phenylsemicarbazide yields a diphenyloxytriazole



which on reduction gives diphenyltriazole



—Note on the latent heat of fusion, by N. F. Deerr. Acid compounds of some natural yellow colouring matters, part 1, by A. G. Perkin and L. Pate. The yellow colouring matters, quercitin, rhamnazin, rhamnetin, luteolin, fisetin and morin form orange or scarlet crystalline compounds with some of the mineral acids; catechin and maceurin do not yield such compounds.—Action of sulphur on α-nitronaphthalene, by A. Herzfelder. On heating a mixture of sulphur and α-nitronaphthalene an amorphous substance is obtained, which probably has the constitution



and to which the name αα[1]-thionaphthalene is given.

Mathematical Society, June 13.—Major MacMahon, R.A., F.R.S., President, in the chair.—Mr. G. H. Bryan, F.R.S., communicated a note on an extension of Boltzmann's minimum theorem, by Mr. S. H. Burbury, F.R.S.—Dr. J. Larmor, F.R.S., gave a brief sketch of a paper by Mr. J. Brill, entitled "On the form of the energy integral in the variable motion of a viscous incompressible fluid for the case in which the motion is two dimensional, and the case in which the motion is symmetrical about an axis."—A paper by Dr. Routh, F.R.S., on an expansion of the potential function $1/R^{\kappa-1}$ in Legendre's functions, was taken as read.—Mr. Macaulay read a paper entitled "Groups of points on curves treated by the method of residuation." The President stated that Prof. A. M. Nash, of the Presidency College, Calcutta, had died on the voyage home, for a two years' furlough, after twenty years' residence in India.

Zoological Society, June 18.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. J. Graham Kerr read a paper on some points in the anatomy of *Nautilus pompilius*. The author advocated the abandonment of the view that the arms in Cephalopods are pedal, and the resumption of what appeared the inherently more probable view, that they are processes of the head-region. In conclusion, the author drew attention to certain indications which appeared to point to the Amphineura, and especially to the Chitons, as being of all living Mollusca those which most nearly approximate to the ancestral form of the time when the Cephalopods diverged from the main Molluscan stem.—A communication was read from Mr. F. E. Beddard, F.R.S., and Mr. A. C. Haddon, containing an account of a collection of Nudibranchiate Mollusca recently made by the latter in Torres Straits.—Mr. Boulenger read a paper on a large collection of fishes made by Dr. C. Ternitz in the Rio Paraguay.—A communication was read from the Babu Ram Bramha Sânyál, giving an account of the moulting of some Birds of Paradise in the Zoological Gardens, Calcutta.—A communication was read from Mr. O. Thomas and Colonel J. W. Yerbury, giving a description of a collection of mammals made at Aden by Colonel Yerbury in the winter of this year. It was shown that thirty-six species of mammals were now known to occur in the Aden district.—A communication was read from Mr. Edwyn C. Reed, containing a list of the Hemiptera-Heteroptera of Chili.—Mr. H. H. Druce read a paper on Bornean butterflies of the family Lycænidæ, in which he had catalogued all the species already recorded from that island, and gave descriptions of a considerable number of new species, principally from Mount Kina-Balu. Mr. Druce stated that the number of butterflies of this family previously recorded from Borneo was about 75, and that his paper contained references to about 220.—A communication was read from Dr. A. G. Butler, containing an account of a small collection of butterflies sent by Mr. R. Crawshay from the country west of Lake Nyasa. Five species were described as new to science.—Mr. J. Anderson, F.R.S., read a paper describing a collection of reptiles and batrachians made by Colonel Yerbury at Aden and its neighbourhood during the past winter.—Mr. Boulenger, F.R.S., gave an account of the reptiles and batrachians collected by Dr. A. Donaldson Smith during his recent expedition in Western Somaliland and the Galla country.

Royal Meteorological Society, June 19.—Mr. R. Inwards, President, in the chair.—Mr. R. H. Curtis read a paper on the hourly variation of sunshine at seven stations in the British Isles, which was based upon the records for the ten years 1881-90. Falmouth is decidedly the most sunny station of the seven, having a daily average amount of sunshine of 4½ hours. This amount is half an hour more than that recorded at Valencia, and three-quarters of an hour more than at Kew. Of the other four stations, Aberdeen, the most northern but at the same time a coast station, with 3·64 hours, has more than either Stonyhurst or Armagh, both inland stations; whilst Glasgow, with only 3 hours, or about a quarter of its possible amount, has the smallest record of the seven, a result to some extent due to the nearness of the observatory to the large manufacturing works with which the city of Glasgow abounds. At Valencia, Kew, Stonyhurst, and Armagh, the maximum duration is reached in May, the daily mean amount varying in the order named from 6¾ to 6 hours. At Falmouth and at the Scotch stations the increase goes on to June, when the mean duration at Falmouth reaches 7½ hours, at Aberdeen 6¼ hours, and at Glasgow 5·6 hours. January and December are the most sunless months of the year. The most prominent feature brought out at all the stations is the rapid increase in the mean hourly amount of sunshine recorded during the first few hours following sunrise, and the even more rapid falling off again just before sunset.—Mr. H. Harries read a paper on the frequency, size, and distribution of hail at sea. The author has examined a large number of ships' logs in the Meteorological Office, and finds that hail has been observed in all latitudes as far as ships go north and south of the equator, and that seamen meet with it over wide belts on the polar side of the 35th parallel.

Royal Irish Academy, June 10.—Dr. J. K. Ingram, President, in the chair.—A paper on a basaltic hill of Tertiary age in county Galway, by A. MacHenry and Prof. W. J. Sollas, F.R.S., was read (communicated by permission of the Director-General of the Geological Survey). The extensive occurrence of basaltic dykes running with a general north-west to south-east direction through the whole northern third of Ireland has been described by Sir Archibald Geikie, who, in a bold but true generalisation, has referred them to the Tertiary period. The authors bring forward evidence of a still more southern and western extension of igneous activity in Ireland during this period, basaltic rocks similar to those of Antrim being shown to occur at Bunowen, seven miles south-west of Clifden, and thus about five or six miles north of the latitude of Dublin. They form a hill rising to a height of 200 feet above the surrounding plain, which is composed of gneissose rocks, through which the basalt has been extruded. The hill trends from north to south, and is 450 yards in length. It consists of olivine bearing dolerite, and vasicular basalt containing unaltered glass, and a substance which has been described[1] as a mineral under the name of "hullite." This substance is shown not only to occur in the vesicles of the basalt as volcanic glass does in the "amygdaloids" of the Tynemouth dyke described by Teall, but also to contribute to the ground mass, where it presents all the characters of an interstitial glass. Its most remarkable character is its extremely low specific gravity (1·76), which is small even for a hydrous volcanic glass, such as this so-called mineral must be admitted to be.

PARIS.

Academy of Sciences, June 17.—M. Cornu in the chair.—The President announced to the Academy the decease of M. Verneuil, member of the Medicine and Surgery Section.—A note on the law of absorption of bands of the oxygen spectrum, by M. J. Janssen.—On the necessarily harmonic form of displacements in ocean rollers, even when the

[1] "On Hullite," by E. T. Hardman and E. Hull (*Proc.* R. I. A., Second Series, vol. iii. p. 161.)

non-linear terms of the equations of movement are not neglected, by M. J. Boussinesq.—On the combination of free nitrogen with the elements of carbon disulphide, by M. Berthelot. (See Notes, p. 202.)—A new combination of argon, its synthesis and analysis, by M. Berthelot. (See Notes, p. 202.)—Preparation and properties of pure fused molybdenum, by M. Henri Moissan. Pure fused molybdenum has been obtained by means of the electric furnace. Its properties and reactions are very fully given in the paper. Among these it is stated to have a density = 9·01, to be as malleable as iron, and capable of being filed cold or forged hot. When heated in contact with carbon, it forms a steel by cementation much harder than the pure metal. It is suggested that molybdenum may be used in the Bessemer process in place of manganese, because it furnishes a volatile oxide disengaged in the gaseous state, and any excess of the metal remaining in the iron would be as malleable as the iron itself, and similarly capable of being hardened.—Action of phenyl isocyanate on campholic, carboxylcampholic, and phthalic acids, by M. A. Haller.—Discovery of a third permanent radiation of the solar atmosphere in the gas from cleveite, by M. H. Deslandres. The line of wave-length 706·55 has been obtained in the spectrum of cleveite gas, using a very luminous tube. This corresponds to a third permanent chromospheric line, leaving now only the green line 531·66—the coronal line not obtained from terrestrial sources. The new line corresponds with a line observed in the argon spectrum by the author, employing argon prepared by means of lithium. It bears out the suggestion of Prof. Ramsay, that argon and cleveite gas contain a common constituent.—Comparative observations with declinometers of different magnetic moments, by M. Ch. Lagrange.—On the molecular transformations of chromic hydrate, by M. A. Recoura.—On some basic halogen compounds of the alkaline-earthy metals, by M. Tassilly.—Action of heat on the double alkaline nitrites of metals of the platinum group: Iridium compounds, by MM. A. Joly and E. Leidié. Among the products of the action of heat on potassium iridium nitrite, the author signalises the compounds: $6IrO_2.K_2O$, and $12IrO_2.K_2O$.—On the ammonium sodium acid tungstates, by M. L. A. Hallopeau. The compounds $16WO_3.3Na_2O.3(NH_4)_2O.22H_2O$ and $12WO_3.4Na_2O.(NH_4)_2O.25H_2O$ are described.—Rotatory powers of some amyl derivatives in the liquid and gaseous states, by MM. Ph. A. Guye and A. P. do Amaral.—On synthesised colloids and coagulation, by M. J. W. Pickering. Synthetic colloids behave, when injected into the vascular system, in a very similar manner to the nucleo-albumins.—On a new bed of "cipolin" in the rocks of the Central Plateau, by M. L. de Launay.—Glacial and fluvio-glacial deposits of the basin of the Durance, by MM. W. Kilian and A. Penck.—On the coexistence, in the basin of the Durance, of two systems of conjugate folds of different age, by M. Émile Haug.—On the Jurassic and Cretaceous systems in the Balearic Islands, by M. H. Nolan.—On the Miocene of the Novalaise Valley, by MM. J. Révil and H. Douxami.—Researches on the sugar and glycogen in lymph, by M. A. Dastre. Lymph contains an appreciable quantity (0·097 per thousand) of glycogen, obtainable by the usual methods. Glycogen is destroyed in lymph, in less than twenty-four hours, by a diastasic ferment (lymphodiastase). Rohmann has shown the existence of a ferment of this kind in lymph. The glycogen appears to be entirely carried by the solid elements, and absent from the liquid plasma. The doctrine that sugar is the circulating form of carbohydrate is thus confirmed.—Modification of the heat radiated by the skin, under the influence of continuous currents, by M. Lecercle.—Demonstration, by a new pupillometer, of the direct action of light on the iris, by M. Charles Henry.—Experimental production of generalised ganglionary lymphadenomia in a dog, by M. Pierre Delbet. The author has proved the infectious nature of this disease, and has isolated the pathogenic bacillus causing it.—On serotherapeutics in cancer, by M. Paul Gibier. Details of serum inoculation in two cases of cancer and the consequent effects.—Kildine Island and its hydrological peculiarities, by M. Venukoff.—The recent earthquakes and their periodicity, by M. Ch. V. Zenger.

BERLIN.

Meteorological Society, May 7.—Prof. Hellmann, President, in the chair.—Dr. H. Meyer spoke on most probable and mean temperatures of the air. He showed by several examples (Berlin, Nertschinsk, Alexandria) that the values of the summit of the curve of frequency and of the arithmetic mean exhibit a relationship to each other which is dependent on cloudiness, and shows diurnal and annual periodicities which are of considerable importance for the characterising of climate. The same speaker next dealt with the applicability of Lambert's formula to the calculation of the average direction of the wind. He showed that later observers had neglected Lambert's presupposition that either the velocity or pressure of the wind must be introduced into his formula, and had employed the "frequency" instead, a fact which must lead to worthless results. But even when the formula is employed in accordance with Lambert's instructions the resultant direction arrived at has no climatic significance. A lengthy discussion ensued, which the President summed up as indicating that Lambert's formula was not generally regarded as sufficing for the calculation of the average direction of the wind. Only in the case where the movements of the air lie close together for a given period, and do not differ by more than 2°, does it appear at all profitable to calculate the resultant by means of this formula.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Garden Flowers and Plants: J. Wright (Macmillan).—Longmans' School Algebra: W. S. Beard and A. Telfer (Longmans).—Bulletin of the U.S. National Museum, No. 48. A Revision of the Deltoid Moths: Dr. J. B. Smith (Washington).—Heligoland as an Ornithological Observatory: H. Gätke, translated by R. Rosenstock (Edinburgh, Douglas).—An Introduction to Chemical Crystallography: Dr. A. Fock, translated and edited by W. J. Pope (Oxford, Clarendon Press).—Leitfaden für Histiologische Untersuchungen: Dr. B. Rawitz, Zweite Auflage (Jena, Fischer).—Das Pflanzenphysiologische Praktikum: Dr. W. Detmer, Zweite Auflage (Jena, Fischer).—Untersuchungen über die Stärkekörner: Dr. A. Meyer (Jena, Fischer).—A Text-Book of the Science and Art of Bread-Making: W. Jago (Simpkin).—The Structure and Life of Birds: F. W. Headley (Macmillan). Photography Annual for 1895 (Iliffe).—Exterior and Interior Photography: F. W. Mills (Dawbarn).—La Géologie Comparée: Prof. S. Meunier (Paris, Alcan).—Mind and Motion and Monism: Dr. G. J. Romanes (Longmans).

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CONTENTS.